THE SOUND ENGINEERING MAGAZINE
APRIL 1981
$1.95

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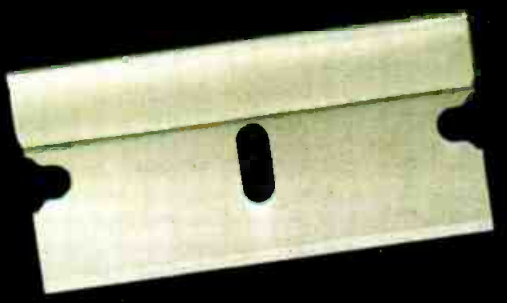
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ABOUT THE COVER—

• Our two-part series on Music In The Studio concludes with another look at the piano—this time from the manufacturer's point-of-view. And, for still another view, see this month's cover.

db

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db Letters

TO THE EDITOR:

Dr. Diamond's article contains references to numerous ideas which have been widely publicized in popular books, including acupuncture, therapeutic use of music and meditation, the influence of magnetic fields on organisms, and the residence of human creative abilities in one hemisphere of the brain. He also refers frequently to "life energy," which is not further defined, but which Dr. Diamond treats as something real. None of these subjects have any inherent relevance to digital signal processing, but are apparently introduced to let us know where Dr. Diamond is coming from, which everyone has already guessed, anyway—southern California.

The only issue raised by Dr. Diamond which appears to belong in a magazine about sound recording is his claim that listening to recordings made from digital master tapes induces stress in listeners. He says that he has proven this by applying a test described in a medical book, written by an authority on the subject. He does not say that such recordings as commercial long-playing records and tape cassettes contain no objective, physical "digital" component. Neither does he tell us in what way the properties of an electric or acoustic signal, that is, the frequency, phase and amplitude of its spectral components are altered, if at all, by the process of digital encoding and decoding. It could be said that Dr. Diamond offers us the downfall of physics and electrical engineering as these are presently understood, on the basis of "electromagnetic" effects which he believes originate in "what we may call the acupuncture central headquarters."

Some people seem to think that science consists of a set of sacred doctrines defended by a priestly establishment; instead, it is really a set of practical rules. Whatever interest we may have in the problem of stress, most of us who read db Magazine are primarily concerned with sound reproduction. We earn our living by applying ideas and principles that have worked dependably, day after day. We do not use them because they

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Coming Next Month

• In May, our topic is Sound With Images, in which we examine various aspects of the video medium. At long last, it looks (sounds?) like audio is getting some much-needed recognition here. We'll have features on video production consoles, techniques, and studios—all to bring you up-to-date on the latest in this expanding field.

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are holy, but because they work. In addition, we can revise or reconsider them at any time, because they are easy to test or demonstrate. If Dr. Diamond is interested, for example, we can explain them in a way that he can understand, and he is welcome to test their consistency, with or without our help.

Good rules, like good tools, ought to be replaced only by others of equal strength and utility. It is here that Dr. Diamond fails. In the absence of an objective "digital" property of the recordings, stress is presumably induced by inner or mystical knowledge of the history of the signal. Dr. Diamond's proposition cannot be said to be right or wrong, any more than a dream can be said to be right or wrong. Rather, his claim has no meaning which would permit its experimental evaluation. Until he can give us a message in English, mathematics or some language which others understand, his articles will continue to be posted on laboratory bulletin boards as amusements, not as assignments.

ROBERT BERKOVITZ
Research Director
Teledyne Acoustic Research

db replies:

For more on the digital controversy, see the special report on page 40

OOPS!

TO THE EDITOR:

The folks at Con Brio inform me that one or two points in my discussion of their ADS 200 music synthesizer ("Zoop, Beep, Brap, Broop," March **db**, 1981) went a bit astray. The keyboard is not velocity sensitive, as suggested, but it does respond to the duration of touch. Furthermore, not just one but as many as four separate voices can be assigned to any one keyboard section.

A more serious possibility for misinterpretation arises in the section on the Fairlight CMI. I described the instrument as silent unless it has received some sort of input. The Fairlight folk want it clearly realized that, instead of applying an actual outside signal source, you can start from scratch with, say, a waveform sketched on the CRT with the light pen. Semantically, one could argue that this also constitutes a form of input, but in the interest of avoiding misunderstanding I think that this point should be stressed.

RALPH HODGES

TO THE EDITOR:

I am writing to add (belatedly) a very important quote which I inadvertently left out of my February **db** "Fonovision International" story.

Noted producer/engineer Eddie Kramer (KISS, Jim Hendrix, etc.) was the first major client to utilize Fonovision. Kramer is, in fact, pictured at the console in the photo on the lower-right-hand corner of your February cover.

"Fonovision," Kramer said, "was not yet fully ready when we went in to cut some songs for a new group. The studio performed admirably, however, on all counts. Fonovision's sound is terrific. It has a feel which is live, but controllable. The interiors are beautifully constructed out of natural woods, with many extra touches like hand-sculptured doors. Looking at the way most studios are built today, it would be extremely difficult to duplicate the quality in the U.S. Colombia too, is a charming country. Only five hours away by jet, great food, friendly people. We are looking forward to working there again."

Two other important credits were also missing from the article. Marcy Ramos designed the air-conditioning system and lighting and electrical design for the studio was developed by Robert Wolsch Designs.

HOWARD SHERMAN



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Case History #17

Engineer/Producer X is smack in the middle of a session with Super Star Y. He is dubbing in the lead vocal.

SSY is great, but he's all over the place, level wise. E/PX patches in a conventional limiter and does a take. On playback, SSY frowns, saying, "Hey man, whatdidja do to my voice—it's all squashed. Look at your meter, friend...my falsetto parts are pegging while my famous grunts and yells are at -6. Are you an engineer or a butcher?"

About this time, Masked Audio Salesman Z appears, and whips out a VALLEY PEOPLE TR804 GOODIE BOX. He takes E/PX aside, points to the GAIN BRAIN II module and says, "Plug in this little gem and giver a try." After a bit of knob twiddling on the GB II, E/PX says, "Wow MASZ, this thing really works. I thought all that stuff about GAIN BRAIN II actually understanding music was just advertising B.S. It *is* intelligent."

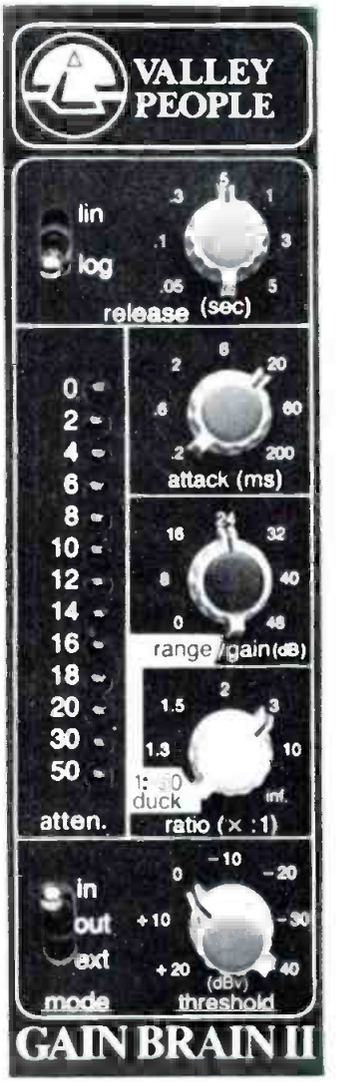
E/PX motions to SSY: "OK dude, get out there and sing. I'll make you a star."

SSY grunts: "Listen turkey, I *am* a star. But since you're so cute, I'll sing for you anyhow. Don't screw it up this time Jack, OK?"

Next playback, SSY is beaming. With his thumbs tucked up under his armpits, he exclaims: "Now *that's* my voice. Check out the range...the control...the feeling. Gawd, it's no wonder I'm a Super Star."

E/PX interjects: "It's the way I put it down, man. Look at the VU...see how I caught every word at just the right volume...no pump and squash. I'm great. Ain't I?"

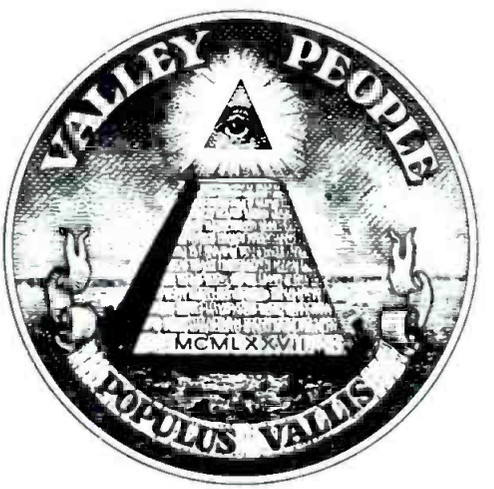
Growing tired of watching E/PX and SSY dancing around the console, Masked Audio Salesman Z prepares to make his exit. As he heads for the door, he is heard to exclaim, "When you guys get tired of patting each other's backs, take another listen to your track. You've got some drum leakage from the phones. When you mix it, run it through the KEPEX II and get rid of the junk. Then you'll have even more to flap your wings about."



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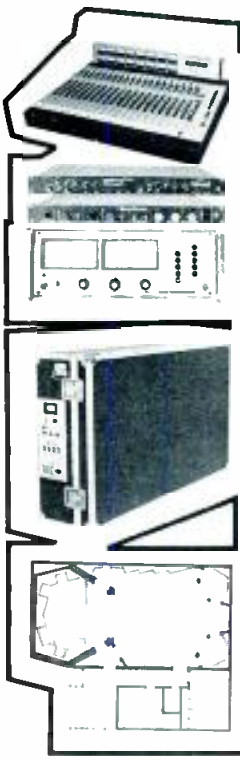
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db Calendar

APRIL

25 **1981 Midwest Acoustics Conference.** Hermann Hall, Illinois Institute of Technology, Chicago, IL.

MAY

5-7 **National Sound and Communications Conferemce.** Hyatt Regency and Atlanta Hilton, Atlanta, GA. For more information contact: Gerald M. Newman, 222 S. Riverside Plaza, Suite 1606, Chicago, IL 60606. Tel: (312) 648-1140.

12-15 **AES 69th Convention.** Los Angeles Hilton, Los Angeles, CA. For more information contact: Audio Engineering Society, Inc., 60 E. 42nd St., Rm. 2520, New York, NY 10165. Tel: (212) 661-8528.

19-21 **Syn-Aud-Con Audio Industry Seminar.** San Juan Capistrano, CA. For more information contact: Syn-Aud-Con, P.O. Box 1115, San Juan Capistrano, CA 92693. Tel: (714) 496-9599.

JUNE

10-12 **APRS '81; 14th Exhibition of Professional Recording Equipment.** Kensington Exhibition Centre, London, England. For more information contact: E. L. Masek, 23 Chestnut Ave., Chorleywood, Hertz, U.K.

21-7/3 **Audio Workshop.** Concordia College, Moorhead, MN. For more information contact: Audio Workshop, Concordia College, Moorhead, MN 56560. Tel: (218) 299-4201.

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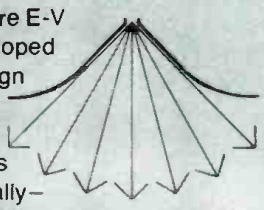


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[1] U.S. Patent Number 4071112

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NORMAN H. CROWHURST

db Theory & Practice

Instrumentation: For Machines & People

• In these days of solid state, instrumentation for machines is commonplace. It is very precise and quite objective. Things that used to bother instrumentation, like the fact that using a meter of inadequate internal resistance could produce a false reading by dropping the very voltage it is supposed to measure, would be strange to modern engineers.

Back in the old days, explaining why that could invalidate a reading was a very difficult point to get across. Most people would assert that the meter was inaccurate when, in point of fact, it was quite accurate. However, it alterred the voltage it measured in such a way as to make true measurement quite difficult.

You measure machines with instrumentation—that is, machines like amplifiers and all kinds of audio equipment. Why, or how, would you measure people? This would seem to be getting out of the audio man's realm, wouldn't it? But it isn't, or shouldn't be.

Among audio professionals, there are those who do a creative job, and those who merely do a job. The latter may do their job quite precisely and accurately, but they are not creative. When I write that, probably some names of people you know come to mind, validating my statement. But how would you measure that? Can you measure such a thing as creativity?

Those audio pioneers, Fletcher and Munson, engaged in measurement that concerned people; how human hearing works. The material they published was mainly the result of averaging, over a great many human "samples," to determine the average characteristics of human hearing. That is one form of result.

If we still had their complete data, we could derive some different information from them; how each "sample" they tested differed from that mean. That, in fact, is what today's audiometrists do: they measure a person's hearing to see how much it deviates from the "norm," or average.

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"Last summer my band, *Gathering Forces*, performed at the Summerpier Festival in New York City. To my initial despair, the sound system they supplied looked like four eccentrically designed hi-fi speakers on poles. This was supposed to handle a highly electrified fusion band with horns and vocals for an outdoor crowd of 2,500!

"To my astonishment, it worked. I decided to try those funny little speakers in my keyboard setup. And I've been using them ever since.

"What the Bose 802s do for keyboards is, basically, to reproduce the full range accurately. The tone characteristics are very transparent, free of the typical boxy colorations. I don't have to stay away from certain octaves or filter settings any more. And feedback doesn't seem to be a problem.

"What's more, I can hear the 802s without blowing my head off. They sound exactly the same at every volume level, something that is definitely unique to these speakers. Plus they're really compact and easy to move around. I can just load them into my VW bus along with my four keyboards and everything else.

"We're now using two pairs of 802s for our band's PA system, with another pair on my keyboards and a few more as monitors. It used to take a whole truckload of cabinets, amplifiers and crossovers to get the same coverage. And the sound wasn't nearly as good!"

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We have shown, in past columns, how people's hearing varies, not only from person to person, but even in the same person. A person can train himself to hear something that previously was inaudible to him. So hearing, much like every other human faculty, is subject to learning, as well as being perhaps the primary means by which most of us (except those who have no hearing) learn.

Instrumentation has subjective aspects, even in audio—perhaps more in the audio profession than in other professions touched by electronics. But what we want to introduce here goes far beyond that.

Let's switch professions for a moment, to see what we're talking about. Educators talk of instruments too. They call them IQ tests, aptitude tests, achievement tests, competency tests, and possibly more. The way they use these tests is very similar to the way some used those inadequate resistance meters in the early days; they take the readings they get as gospel.

Have you ever taken such tests? There may be a question, "Name the mountain on whose face is carved the faces of certain American presidents?" You were glad you knew the answer to be Mount Rushmore. But, what if you didn't happen to know that fact? Does that reflect on your IQ, aptitude, or whatever? Suppose the question had asked for the name of a certain totem pole somewhere in New Zealand; would you have known that? And yet, a Maori would have known that, and probably would not have known the name of Mount Rushmore.

We recall an incident in the early days of so-called competency testing. At a local chamber of commerce meeting, a teacher and a psychologist explained the philosophy of this kind of test; why it could better indicate a student's ability than any of its predecessors. After the presentation, the chamber members asked questions, for which the presenters were all primed, and everyone present was almost convinced that finally the schools were doing something useful.

But also present, because that was timber carnival week, were half a dozen school girls of the timber carnival's queen's court. And one of these girls asked permission to ask a question. Given leave, she asked, "How is a competency test different from any other, when the teacher gives us the answers the day before the test?" The presenters tried to suggest that, if that happened at all, very few teachers did it. But that only made matters worse, because the other girls testified that they had seen many teachers do that.

That shows only one way in which an educator's "instrument" can be invalidated and, if we are to believe those girls, it often is. The audiometrist has devised ways to prevent a subject from "faking" his results on an audiometry test. But what that girl said points to one of the weaknesses of today's educational testing, and may well explain why, in spite of more comprehensive testing, the quality of school graduates continues to go down, academically.

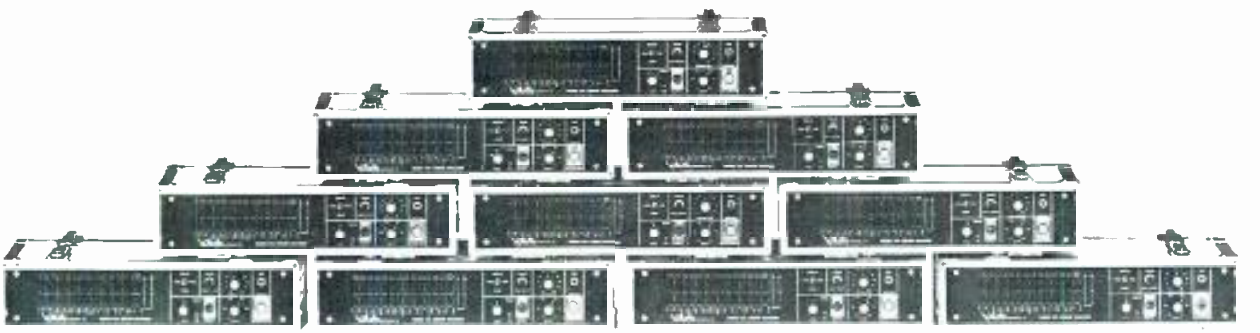
But we are more concerned with the audio profession. Some who read this publication may be concerned with kindred professions. Too many professionals, like people in other walks of life, want ready-made answers; don't bother them with theory or the facts, just give them the answer. Fortunately that girl at the chamber of commerce meeting wasn't satisfied with that. But too many people want nothing else today. Life's too busy, they'll say, to bother with details.

What they don't seem to realize is that by behaving in that manner, they are being programmed to behave like computers—and rather inefficient ones at that.

Elsewhere, I responded to some of the discussion in the January issue, about the stress factor in digital recording.

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Objective measurements show that digital recording can be much more precise than analog. Yet subjective measurements show that a person listening to digital recording suffers stress not induced by the apparently identical program recorded in analog.

The objectivist argues that that cannot be. There must be some other explanation. Could it be that everyone who listens to digital recording had something for breakfast that didn't agree with his stomach?

In previous columns, we have introduced the use of audio cassettes as an educational tool. Properly used, these can expedite learning by a tremendous factor, and also increase teacher efficiency. Teachers that formerly were handling only 20 to 25 students, can handle a class of over 100, with relative ease.

But what about the way those students learn? That brings in the measurement question. That is something we have to answer, if we are to satisfy the critics (most of whom belong to the NEA or its affilitates, and want more teachers, not less). So we had to design tests that would provide a definitive answer to that question.

All existing tests used by educators, like the one the girl at the chamber of commerce meeting spoke about, determine whether the candidate knows the answer to a specific question. He or she, at that particular moment, either knows or doesn't know the answer. A third alterntive, that educators have devoted a lot of time to, is the possibility that a candidate might guess. They have spent millions of dollars formulating tests to cancel out the effects of guessing.

But they have spent virtually nothing to determine the degree to which learning happens, or to measure creativity. And those are important aspects in which mediated instruction can have a part. Let us generalize, to show the properties of such a medium that we can use. Earlier in the history of mediated instruction, some developers came up with progamming. Have you ever read a programmed book?

In a programmed book, you read a segment and then it will ask you a question, to which it gives you multiple choice answers. Then are instructions, such as, if you chose answer A turn to page 43, if you chose answer B turn to page 57, and so on. Each page you turn to then takes up, based on the reason the psychologist who prepared that book believed would cause you to pick that answer, what will be necessary for your problem in learning.

The book is programmed, and through it, the student is programmed, by the psychologist who designed it. There may be 20, 50, 100, different courses that individual students can pursue through the book, each carefully preselected by the book's designer. If you've ever studied one, you'll know that you didn't get far before you found that you were a type of student the designer hadn't bargained on!

Well, in designing these mediated materials, we found a different way to go, that makes the flexibility almost infinite, enabling the student to match the learning to his individual needs.

In our courses, we decided to have a first and last lesson. The first to explain to the student how he could go through the rest, and how the method of study differs, and the last to pull it all together, and suggest ways to go on learning from there. So we have 26 lessons, of which only number 1 and number 26 have a specified place in line. The rest the student may take in whatever order suits his fancy.

The other 24 lessons can be taken in any order, meaning that the number of possible study sequences for that course is factorial 24, or more than 6×10^{23}, or 600,000,000,000,000,000,000,000. Each lesson, or segment, has at least 60 questions for the student to take, after pursuing the audio material with his workbook. Each question can be answered correctly or incorrectly, at the very least, so there must be at least 2^{60}, or more than 10^{18}, which is 1,000,000,000,000,000,000, different possible sets of right and wrong answers to that one test.

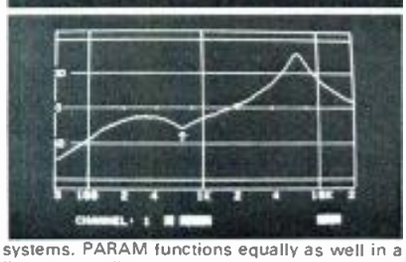
Here is the point: the student finds his own course, and gets an indication how to correct his course. Further, the material is designed to stimulate learning. It is not designed merely to test retention, which virtually all of the traditional tests do. It prepares the student, in the mediated material, to move ahead on his own. He is shown something, then stimulated to learn from that something he is not shown. His creativity is developed.

The tests that we have developed to go with the course can measure that creativity. Educators will tell you that it is impossible, because they have never done it. All of modern education is based on behavior training, or retention. Psychologists develop teaching methods and tests by studying the behavior of animals. Anything based on that cannot possibly be creative.

We believe, in conclusion, that audio people are singularly equipped, from their experience with audio and hearing, to move into this new arena. We would distinguish it from what is commonly called mediated instruction, which is nothing more than putting already crumby textbooks into mediated form, as being mediated learning, in which the student is no longer a guinea pig, but controls his own learning and, as tests have shown, can reach rates of progress that have not been dreamed of for generations now. ■

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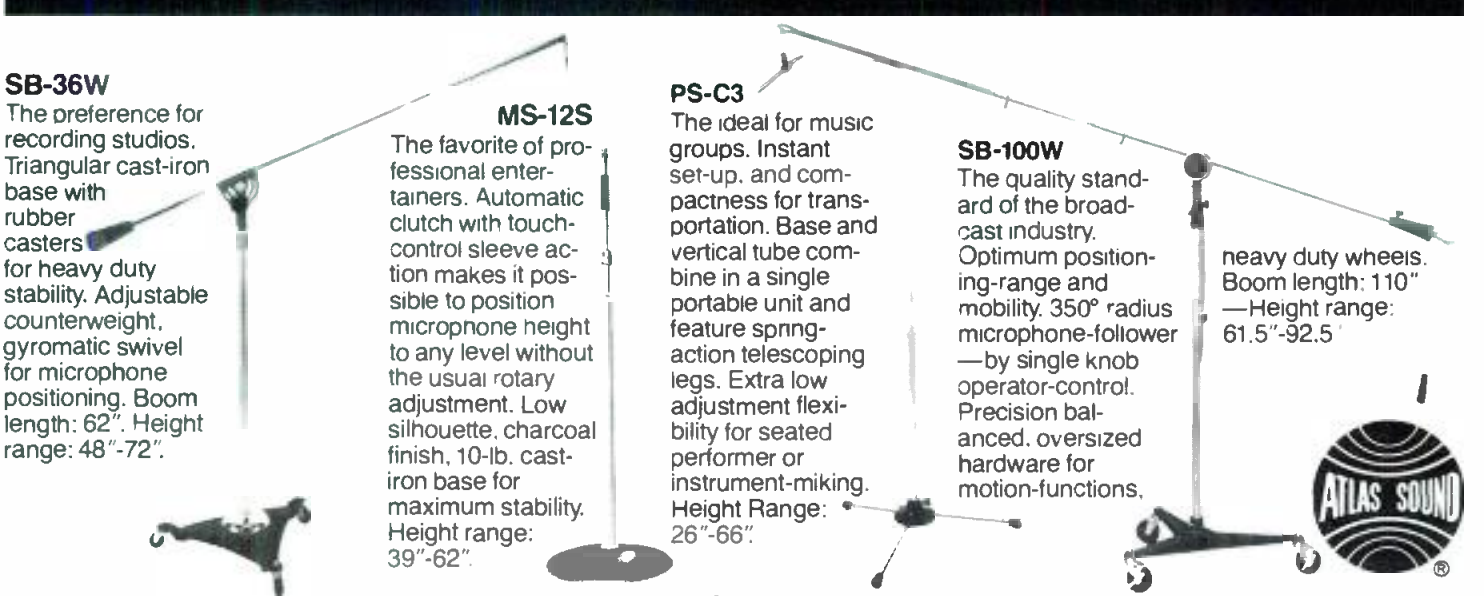
Clipping

• In the previous article, we discussed the nature of digital distortion and we came to the conclusion that it was not a big issue. Distortion is like noise; both are kept low by the large number of bits in high-precision converters. However, in the region of overload there is a type of distortion which *is* significant, and with which the audio engineer is already familiar. In analog audio, peak and VU meters are an attempt to provide a monitor facility to avoid saturation or clipping in all of the audio equipment in the audio chain. Digital equipment is also sensitive to clipping.

HARD LIMITING

The A/D conversion process obviously has an inherent hard limit built in, since the digital word cannot exceed the maximum value of the word size. For discussion purposes, let us define the range of all digital words as being from +1 to −1. This is an arbitrary definition in that the digital word does not have an inherent dimension of volts or amps. Since the word is limited, any audio signal which is larger than the maximum of +1, or less than the minimum of −1, cannot be represented accurately. Most converters will just clip, representing any signal above +1 as if it was +1. This kind of clipping is very hard. In terms of a limiter notation, the compression ratio is ∞. Some audio equipment allows for overload by virtue of a soft limiting, or gradual saturation process. An analog tape recorder has no clearly-defined limit point; the transfer curve just becomes more saturated. The usual specification of the limit level of a tape recorder is therefore specified in terms of distortion. The maximum signal level at 3 percent harmonic distortion is more than that corresponding to a 1 percent harmonic distortion level.

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The hardness of the digital limit does provide a certain simplicity. To allow for overload margin based on VU and peak measurement, we must redefine the nominal signal level. A typical digital audio system will define a "nominal" signal level which is 6, 12 or 20 dB below the internal clip point. The overload margin is that margin which is observed from outside the equipment. If we define an overload margin as 20 dB then we are saying that the nominal signal level is a factor of 10 below the A/D's clipping point. We need not deal with a distortion criterion as we did with an analog tape recorder. Up to clipping there is no distortion. Above clipping there is instant distortion, and it increases rapidly.

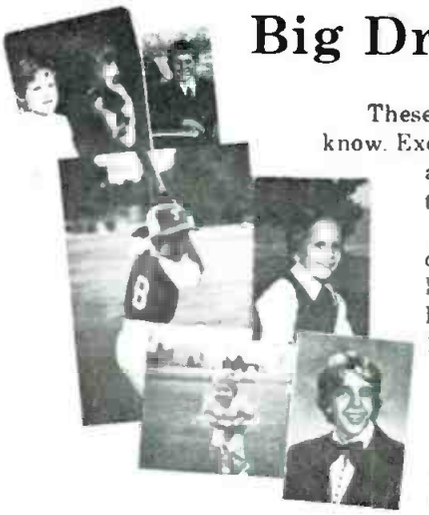
NON-HARMONIC DISTORTION

Clipping would appear to be a well-understood phenomenon. A clipped sine wave produces odd harmonics of the clipping is symmetric and all harmonics if unsymmetric. Similarly, it also produces extensive intermodulation distortion if more than one frequency is present. The interesting aspect of digital clipping is that the harmonics may beat with the sampling frequency and be moved to other frequencies. There are many ways in which we can demonstrate this. The digital word can only contain frequencies which are less than half the sampling frequency. What happens to the fifth harmonic of a 9 kHz sinewave in a 50 kHz sampling system? The answer is that it becomes 5 kHz, since 5 x 9 kHz is 5 kHz less than the 50 kHz sampling.

Yet another way to look at this is in terms of the anti-aliasing filter. This filter is to remove all components which are above half of the sampling frequency. Even if the filter is perfect, high frequencies could appear at the A/D converter if they are generated *after* the filter. Overloading the converter is like adding the illegal components and short-circuiting the function of the filter.

Clipping can thus be very bad if it is caused by steady-state high frequency signals. It is quite possible to create a case for audible distortion products leaving a digital audio system without any apparent input entering. The answer is that a very high frequency product beats with the sampling rate.

To complete this discussion, we should note that distortion in the sample-hold shows the same effect as does distortion within the anti-alias filter. The only pure method available to avoid this is the limiting or clipping of the input signal before the anti-alias filter. The filter can then remove the distortion products which would beat with the sampling rate. Consider the fifth harmonic of 9 kHz. This would be in the stop band of the filter and it would be removed. Input clipping makes the overload properties identical to the analog equivalent because the clipping is analog.



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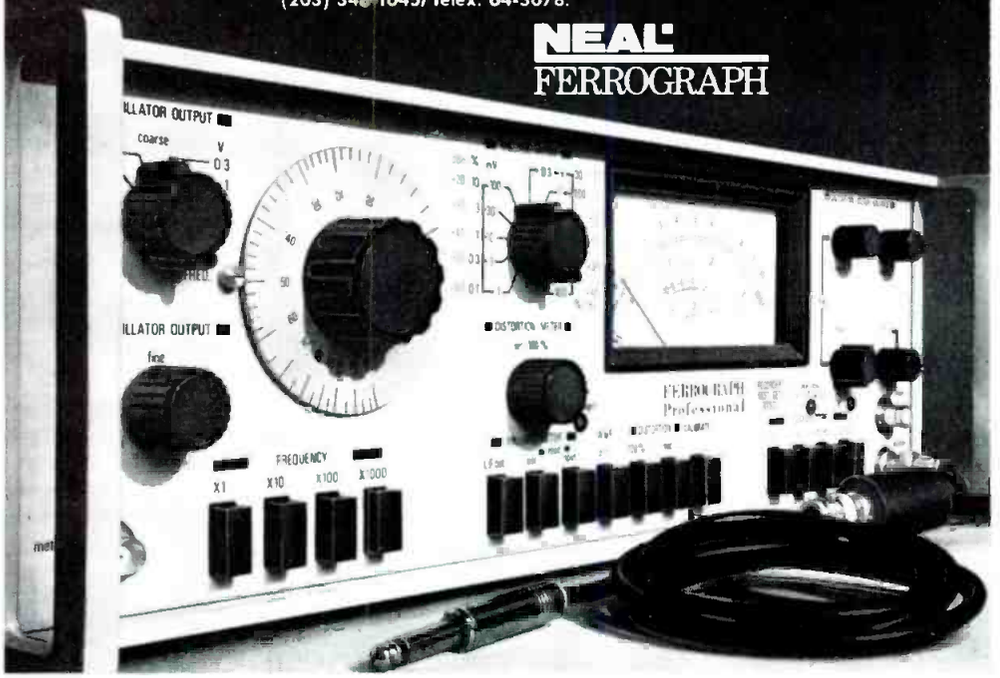
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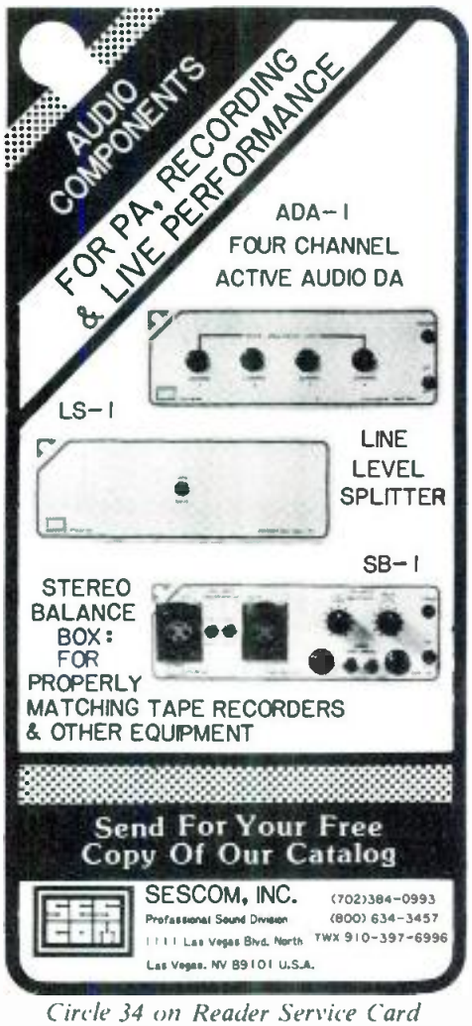
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There is a problem if this is to be done in a purist fashion. A 9 kHz square wave, when lowpass filtered at 20 kHz, results in a 9 kHz sine wave whose amplitude is larger than the original square wave. This is difficult to prove without higher mathematics but one can try it in the studio quite easily. Take a variable lowpass filter and a square-wave generator. Slowly lower the lowpass cut-off frequency and observe that the peak value of the output increases by about 3 dB. This effect would mean that the input analog limiter would have to be set 3 dB below the actual digital clipping level. Such perfection is generally ignored since the level diagram is dimensioned such that the signal never clips. Because the digital domain has so much dynamic range, we can leave a much greater margin for peaks.

SIGNAL MONITORING

If one does not leave a full 20 or more dB for overload margin, then one is faced with the task of monitoring the signal level. Digital clipping is instantaneous, whereas VU ballistics require many hundreds of milliseconds, and even the peak reading meter is on the order of 1 msec. Neither is fast enough for signals generated by synthesizers. These can have peak-to-average ratios of more than 20 dB and the peaks can be 100 μsec. wide.

Quality signal monitoring may only be possible by using the internal monitors provided on the digital audio equipment itself. These monitors display the actual state of the A/D converter. When the converter produces a code such as 011111111 or 100000000 the overload light is illuminated. These codes are the maximum and minimum that the converter can generate. A monostable is used to hold the display light on for at least 100 msec in order to enhance visibility. Otherwise, one would not see the indication of overload.

Other level lights show when the signal is below certain other thresholds. For example, the codes 001111111 and 110000000 indicate that the signal is 6 dB below clipping; the codes 000111111 and 111000000 indicate that the signal is 12 dB below clipping. The rule for converting the digital word to level monitoring is based on the number of high-order bits which are the same. Notice that when the signal is between -6 and -12 dB from clipping, the two high order bits are the same. Between -12 and -18 dB, the three highest order bits are identical. The logic to implement these thresholds is relatively simple.

It is much more difficult to monitor levels other than at 6 dB intervals. Although it is possible to create intermediate values, the difficulty makes it unattractive to do so. In the future, some of these level monitoring displays may be remote transmitted to the operating console.

LOUDNESS BALANCE

Using the peak value in the digital sense means that the level control is less-and-less based on the loudness of the signal. To keep a digital tape recorder in loudness balance requires that the nominal level for the entire program be kept low enough to allow for the worst case signal. This class of trade-off is familiar, but the recording engineer must note that the digital tape recorder is the most severe element. We avoid the issue entirely by sacrificing some headroom in the digital equipment. We can now begin to see why 90 dB of dynamic range may not be so much more than we need. If 20 or 25 dB is allowed for worst-case headroom, then the perceived S/N is reduced to about 70 dB. Unfortunately, moving much beyond 90 dB is both difficult and expensive. Non-synthesizer music is less difficult since the peaks are generally lower, relative to the average.

The studio engineer clearly has a philosophic choice. He can use a 20 dB headroom and ignore the clipping issue, but he will have a higher noise floor. Or, he can squeeze more S/N out of the system by allowing an occasional clipping. Interestingly enough, clipping is not audible with most program material. A high narrow peak itself contains large amounts of high frequency energy. Clipping just changes the spectral balance slightly. The previous discussion on high frequency clipping assumed a more steady-state condition. In that case, the beat tone could be heard. However, if the clipping duration lasts for only 200 μsec., then it is almost never audible.

A final choice for level dimensioning is to sacrifice 2 dB by including a soft limiter. The softness makes the overload issue identical to a tape recorder. No sharp edges are produced. The only cost is 2 to 3 dB of S/N or some distortion in the region from -3 dB to clipping.

A final comment: compared to other analog equipment, the 90 dB of range is sufficiently great that a good compromise can be found. Nevertheless, it is a compromise. ■

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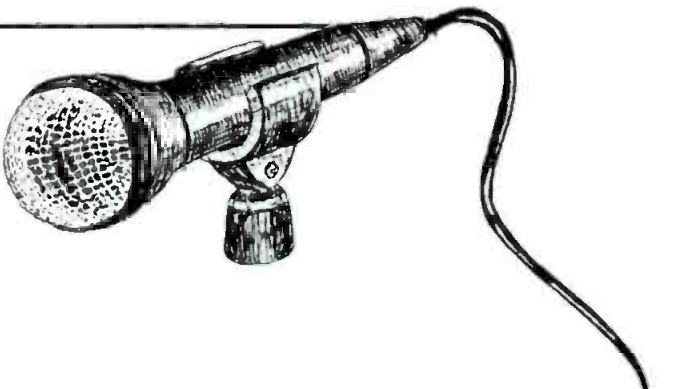
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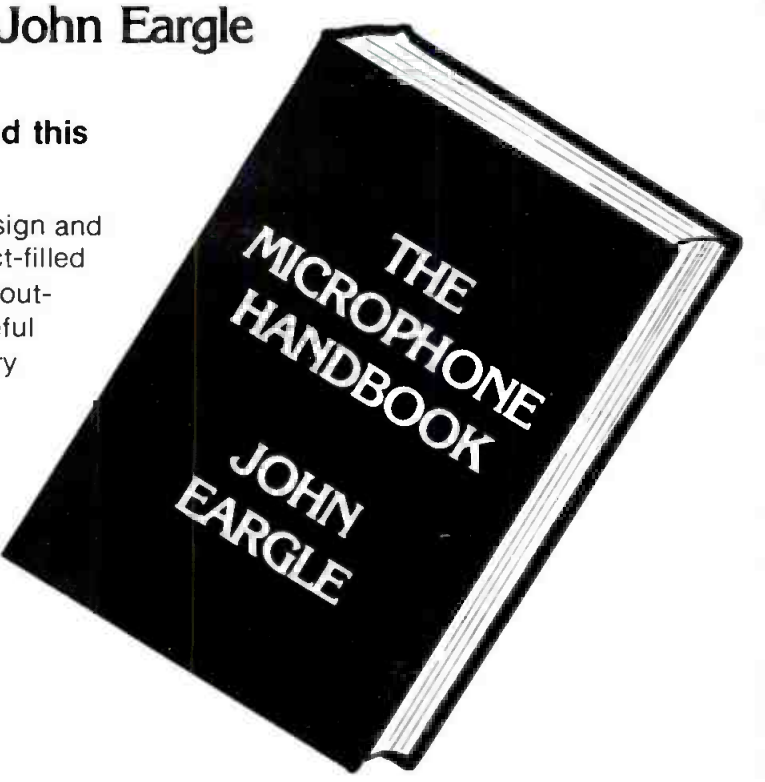
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db Sound With Images

The NHK System

• At the end of February, CBS demonstrated in Washington what many believe is the future of television here—because it is already the present of televison in Japan. HDTV, or high definition television, is the code name given to a combination of technologies all aimed at increasing the fidelity of TV's picture. However, the centerpiece of the CBS demonstration, as well as the central technology of any HDTV, is the camera-to-monitor system employed by NHK, the Japanese Broadcasting Corporation. This month we'll describe that system in brief, and the changes that will be necessary in our broadcasting industry to put the system into usage.

The NHK system was first demonstrated at the Society of Motion Picture and Television Engineers conference in San Francisco, in early February. We missed that U.S. debut, but caught CBS's act in Washington. Twelve years in the making, the camera-to-monitor system scans at 1,125 lines, instead of the present 525 NTSC standard—the single greatest drawback to video image. NHK's creation also features brighter color than our current standard, and a broader screen ratio (5:3, as opposed to the current 4:3).

CBS simply aimed one NHK camera (made by Ikegami) and one NTSC standard camera out their office window,

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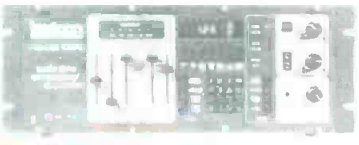
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and showed the difference first on two 19 inch monitors. The difference, of course, was obvious, and even more obvious when tapes produced by each camera—the NTSC taped onto an analog, broadcast quality, quadraplex recorder, then the NHK taped by a Sony digital recorder which used a "bit reduction" process developed at CBS Technology Center in Stamford, Conn.—both were fed into projection TVs. But the projectors were not equal either. For the NTSC picture, a commercial home video projector was used (Advent's model 1000), while an experimental Matsushita projection model was used for the experimental signal. This difference in projectors certainly made the whole demonstration neither fair nor scientific, but it did demonstrate even more acutely the difference between what is and what might be.

The demonstration was given mainly for the benefit of several folks at the NAB, and especially for the good people of the FCC. CBS does not have the easiest sell in the world ahead, because the hitch in the system is that it requires a substantial part of the spectrum for broadcast. That section of the electromagnetic spectrum is also coveted by others, and therein lies the rub.

The contested frequencies are the 12 gHz, DBS range—virgin spectrum, just now. Present TV channels are far too narrow to carry the wideband signal (they are only 6 MHz across), just as even Sony's digital tape recorders would be unable to encompass a signal so wide without CBS's bit reduction. Unfortunately, also desirous of the 12 giga-Hertz range is Comsat's Satellite TV Corp., which proposes to use it for transmitting conventional NTSC signals directly to homes. CBS proposes, for the near term, to use the bandwidth to broadcast only for industrial uses.

Even if CBS gets its wish, and the FCC assigns all the 12 gHz range for HDTV, the bandwidth of HDTV signals will still need to be compressed—in analog form or in encoded form, they are simply too wide for the frequency. CBS's bit reduction technology was demonstrated by John Rossi, the engineer in charge of its development in Stamford. Megabits per second used to make the HDTV picture are 114, and can be reduced to 28 for recording or transmission. Compared to the typical TV picture one is used to seeing, this reduction was negligible—in fact, most viewers at the demonstration could not detect any difference with "the naked eye." And that was when the difference was observed on that experimental Matsushita projection TV. "At 28 megabits per second," said Rossi, "HDTV signals can be transmitted via microwave through any channel capable of carrying at least a 15 mhz base bandwidth signal... But this is just the start of a new technology, and with more complex circuits, higher bit rate reduction can be achieved."

CBS vice-president of engineering and development Joe Flaherty said that bit reduction would one day permit the transmission of high definition TV signals in the VHF and UHF bands, but suggested that terrestrially broadcast HDTV will lag several years behind the satellite-delivered service that CBS would like to begin.

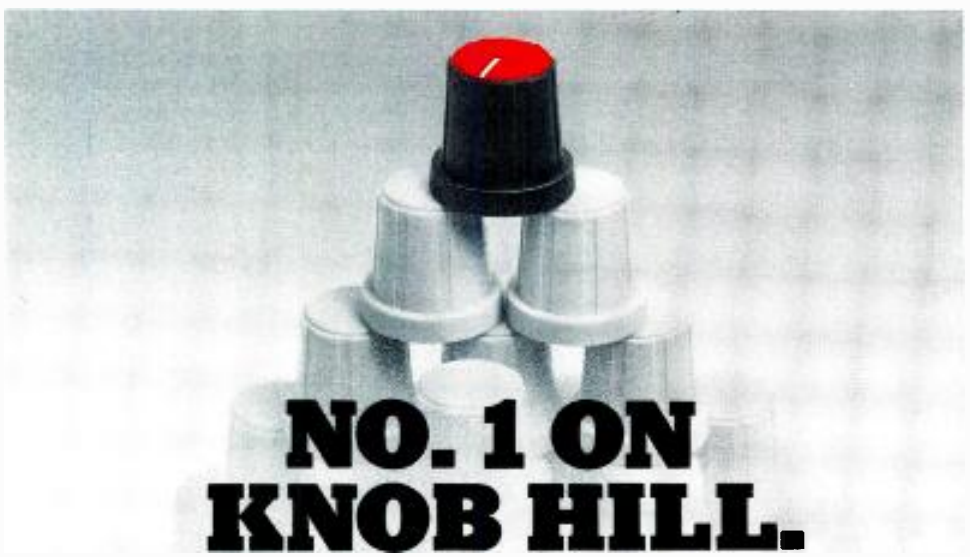
Actually, digital technology is advancing so quickly that by the time CBS's use of the frequencies it desires is approved, their own contribution to the process, the bit reduction, may not even be needed. Flaherty estimates that recorders capable of squeezing in the entire 114 megabits are only as far off as early 1983. If past actions are any indications, the FCC will take at least a century longer than this to make up its collective mind.

Two other major attributes of the NHK system seem particularly welcome. The first obvious one is that, of course, the system includes stereophonic sound. (And, as any of us who have been involved in digital recording are aware, generation or broadcast signal degradation are practically eliminated.) But, back to the first attribute. There has been a lot of talk about stereo TV in this country lately, but a half of a Friday at the CBS demos convinced this reporter that when Mr. Flaherty warns that, without approval of the 12 gHz bands, the United States will be stuck with just the quality of television we've now got "for the next twenty years"; that's about the size of it. "We can't think of going into the next century with the world's lowest quality television standards," he said.

Finally, according to Broadcasting Mag's report on this conference (it's wonderful to have a longer deadline!), the president of Comsat's Satellite Television Corp., John Johnson, was given a private demonstration after hours—and emerged saying that HDTV service over DBS frequencies, "certainly will not be commercially feasible in this decade." (Broadcasting's quote.)

Well, to these callow eyes, it didn't look ten years away, if our backward TV industry might only *do* what it can easily make a great deal of money doing. Is this reporter merely whistling in the wind (I could have made that metaphor a little raunchier) or will he have to travel to Japan to gleefully get his fat little hands on those HDTV cameras, those Sony digital video recorders, or even CBS's bit reduction unit? If we must turn in our film cameras for video equipment (see last time's column), can we not at least demand video equipment that is up to the state of the art? Oughtn't we all to start writing congressmen?

Stay tuned, we'll keep you informed. ■



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db New Literature

CATALOG OF TEST ACCESSORIES

• The 1981 Pomona Electronics catalog includes over 450 black and white photographs and 30 drawings of such test accessories as banana plugs, jacks and patch cords, phone tip jacks, plugs and connecting cords, test clips, probes and holders, binding posts, black boxes, and sockets. Also included in the catalog: electrical data, cable and wire description charts and metric and temperature conversion charts. **Mfr: ITT Pomona Electronics, 1500 E. Ninth St., Box 2767, Pomona, CA 91769.**

NEW PRODUCTS BULLETINS

• New low-cost duct silencers are described in two new bulletins from AeroAcoustic Corp. Four models are available, covering a range of acoustic performance in normal to very low resistance to airflow applications. Models are available covering silencer face velocities from 1000 to 4000 per minute. **Mfr: AeroAcoustic Corporation, 4876 Victor St., Jacksonville, FL 32207.**

AUDIO/VIDEO INTERFERENCE CONTROL PRODUCTS

• A new catalog from Electronic Specialists presents their line of Audio/Video interference control products. Protective devices are also included. Descriptive sections are included which outline particular problems. Suggested solutions are given. Typical applications and uses are also outlined. **Mfr: Electronic Specialists, Inc., 171 South Main St., Natick, MA 01760.**

CATALOG OF HARD-TO-FIND TOOLS

• This new catalog features 15 pages of test equipment and contains more than 2,000 tools of interest to field engineers, technicians, instrument mechanics and others. Major categories covered include: test equipment, micro-tools, soldering equipment, tweezers, screwdrivers, power tools and a complete line of tool kits and tool cases. **Mfr: Jensen Tools Inc., 1230 South Priest Drive, Tempe, AZ 85281.**

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db New Products & Services

MID-BASS HORN



• The M-80 is a new flush-mount, radial mid-bass horn from Community that accepts either a 10-in. or 12-in. cone speaker. The M-80 is part of the Community Boxer series, sharing the same 28-in. wide format as the Super 90 Radial Horns and the Boxer Bass flare. The M-80 is a self-contained unit with a domed fiberglas compression chamber which bolts to the back of the horn. The dimensions of the M-80 are 22½-in. x 28½-in. x 22¾-in.

Mfr: Community Light and Sound, Inc.

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MICROPHONES

• Four new remote Artist Series microphones have been introduced by Audio-Technica. The fixed-charge, permanently polarized condenser electret microphones—models ATM10R, ATM11R, and ATM91R—feature Audio Technica's backplate electret technology. The result is a broad frequency response range of 30-20,000 Hz for each model. The ATM10R is an omni-directional microphone for instruments; the ATM11R is also for miking instruments but is unidirectional, and both the ATM31R and ATM91R are unidirectional models. The ATM31R is intended for instrumental and vocal use and the ATM91R is specifically a vocal unit. Nine volts d.c. powers the new Artist Series units which operate from external power sources of 9-52 V d.c., making it unnecessary to match electronic components to successfully power the microphones. The microphones have maximum input sound levels of 141 dB SPL at only one percent THD.

Mfr: Audio-Technica

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INSTALLER'S TOOL KIT



• The JTK-85 is a new kit for the installer of sound systems, cable TV, remote controls, alarm and security systems. The JTK-85 contains over 100 tools including: hole saws, masonry drills, wood boring drills, a multi-tip speedriver, ten regular screwdrivers, magnetic studfinder, a drywall saw, grounded outlet tester and soldering equipment. The kit is housed in a two-pallet case. An additional multi-pocket tool pouch for carrying tools in confined areas is also included.

Mfr: Jensen Tools Inc.

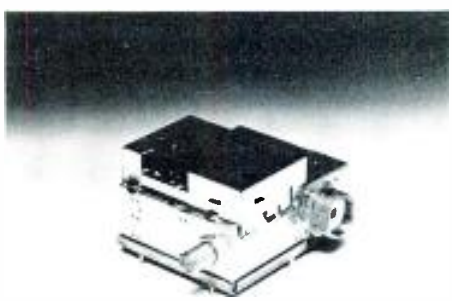
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DOWNCONVERTER

• A new downconverter featuring a crystal-controlled local oscillator is now available from Standard Communications Corp. Designated the MDSD-20, it is able to receive a microwave signal between 2150 and 2162 MHz on either MDS channel one or two, and convert it to VHS frequencies for input into a standard VHF television receiver. A unique feature of the MDSD-20 is the low noise RF preamplifier. Models of the MDSD-20 are available tuned to channels two through six, permitting easy connection to existing TV sets. Power is supplied by Standard's FPS-20 set-top fixed voltage power supply, which provides a stable fixed output voltage over a wide range of temperature and line voltage variations.

Mfr: Standard Communications Corp.

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DIFFRACTION HORNS



• The Model D90-8 and D90-9 diffraction horns are made of Technoplast, a non-petroleum based material that, according to its developers, is stronger, lighter and less resonant than fiiberglas, metal or foam plastic units. Both the D90-8 and D90-9 are compact horns useful when size is critical. The D90-9 is smaller, with a slightly reduced mouth and depth. The D90-8 may be used with 15-in. woofer stage monitors, the D90-9 with 12-in. stage monitors, and both are perfect for portable speaker systems.
Mfr: Integrated Sound Systems, Inc.
Price: $30.00
Circle 49 on Reader Service Card

FUNCTION GENERATOR



• The 1200A is an improved version of Krohn-Hite's Model 1200 Function Generator. The special feature of the 1200A is the inclusion of the "Waveguard" output protection circuit at no extra cost. This feature was formerly available only as an added option. The Waveguard circuit automatically recovers when the short-circuit or voltage is removed from across the generator's output terminals. The Model 1200A provides 20Vp-p sine, square and triangle waveforms from 0.2 Hz to 3 MHz and provides 1500:1 linear up or down sweeps, with adjustable sweep durations from 1000s to 1 ms.
Mfr: Krohn-Hite
Price: $395.00
Circle 50 on Reader Service Card

REVERBERATION SYSTEM

• NEI has introduced the newest member of its signal processing family: The 351 Reverberation System. The 351, with SAR (Signal Activated Reverb), is designed to provide spring reverb performance without many of the problems normally associated with spring reverbs. NEI's SAR, along with special spring drive circuitry, reduces and eliminates spring slap, feedback, and rumble due to high SPLs SAR is user-defeatable via a front panel switch. The 351 includes a five band graphic equalizer and mix/percentage control for the duplication of the reverb characteristics of almost any room, or the creation of reverb effects for voice or instrument. Slide controls of the equalizer section are center detented for easy return to "flat." A mute switch momentarily interrupts the 351's input signal for easy comparison of wet and dry signals, as well as reverb decay.
Mfr: Neptune Electronics Inc.
Price: $329.00
Circle 51 on Reader Service Card



HEADSET STATION

• A Headset station that combines a push-to-page button and volume control is now available from the David Clark Company. The Model M3124 also includes a preamplifier in a small module designed to fit into a standard electrical wiring box. The M3124 accepts the plug from a headset and enables the user to page throughout the entire communications system simply by depressing the page button. The M3124 is an integral part of Clark's Series 3100 Communication System. The Series 3100 is modular-designed for easy installation and interference-free operation, and can be powered by battery or standard 110 VAC. It accommodates up to 32 stations or noise-attenuating headsets.
Mfr: David Clark Company
Circle 52 on Reader Service Card



CABLE JACKETING

• Used to bundle and protect wire and cable, the new ZT jacket was developed as an alternate material for use in nuclear, aerospace, and other installations where PVC materials are not allowed. It offers toughness and resistance to most chemicals and oils and is extremely flexible throughout its temperature range of −100 degrees to +250 degrees. Installation of the flame-retardant polyurethane jacket is easy. The jacket is cut to length, wrapped around the wire or cable, and zipped shut with a patented closure trac. The trac can be opened for inspection or permanently sealed.
Mfr: The Zippertubing Co.
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continued on p. 30

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TEK TM 500 MODULAR INSTRUMENTS

DESIGNED FOR CONFIGURABILITY

The quickest distortion measurements for the most critical applications.

The AA 501 Distortion Analyzer and SG 505 Oscillator measure harmonic distortion, level, and intermodulation distortion. Automatically.

This pair of TM 500 Plug-ins makes distortion measurement truly automatic to save you both time and money. For production testing, the AA 501's automatic speed provides substantial labor reduction with no loss in accuracy. Together, the AA 501 and SG 505 have the lowest harmonic distortion plus noise (THD+N) rating in the entire industry: 0.0025%.

The SG 505 Oscillator outputs a sine wave with the lowest residual distortion on today's market (.0008%). The AA 501 Distortion Analyzer uses digital processing to lock in on test signals, set levels and adjust the notch filter for nulling. All measurements, including dB levels are precalculated and then displayed on an LED readout.



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In addition to level and harmonic distortion measurements, the AA 501 measures intermodulation distortion to three standards: SMPTE, DIN and CCIF difference tone. Automatically selected.

The AA 501 and SG 505 are both TM 500 Plug-ins that can be installed in any of five mainframes, including rackmount, bench and portable. They can also be separated and still used as a team, even though miles apart. Or configured with over 40 other TM 500 Plug-ins currently available.

To find out more about the AA 501 Distortion Analyzer and SG 505 Oscillator, contact:

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continued from p. 28

POWER AMPLIFIER

• The PA-700 offers 355 watts per channel into 4 ohms, 210 watts into 8 ohms and when mono-bridged the PA-700 puts out 710 watts into an 8-ohm load. The high input sensitivity allows the power amp to handle almost any preamplifier audio signal, and a sophisticated LED loss of feedback clipping indicator provides positive warning when clipping occurs on either channel. The welded steel chassis of the PA-700 makes for solid roadability.



Mfr: E-V/TAPCO
Price: $1,095.00
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GRAPHIC EQUALIZER

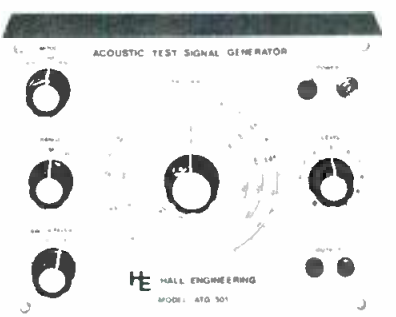


• The SG20 Dual Ten Band Graphic Equalizer is a new addition to Stage's line of professional signal processing equipment. The SG20 is rack mountable and features two channels, each consisting of ten center detented slide pots with plus or minus 12 dB range and center frequencies ranging from 30 Hz to 16 kHz; individual channel defeat switches, and quiet, distortion-free operation. The SG20 is designed for use with high level sources, such as send and return circuits found in P.A. mixers, studio boards and some instrument amplifiers. It can also be used between high level instruments and amplifiers.

Mfr: G&W Unicord
Price: $235.00
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ACOUSTIC TEST SIGNAL GENERATOR

• Hall's Model ATG-301 is a source of white noise, pink noise, and finite octave bandwidth pink noise. It can be used with any sound-level meter or microphone to provide the same accuracy in measuring frequency response as a 1/3 or 1/9 octave spectrum analyzer. The Model ATG-301 provides exactly the frequency and bandwidth desired for as long as necessary and is therefore more convenient than a pink noise record. In the bandwidth mode, the center frequency is variable from 20 Hz to 20 kHz and bandwidths of 1, ½, 1/3, 1/5, 1/10, and 1/20 octaves are available. A unique feature of the signal generator is that correction for sound level meter or microphone frequency response can be read off the front dial.



Mfr: Hall Engineering
Price: $299.00
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HEAD MOUNT ASSEMBLY



• A new die-cast head mount assembly which improves tape alignment and tape tracking has been introduced into all high-speed cassette copiers and duplicators made by Pentagon Industries. The assembly includes the aforementioned die-cast head mount, a newly designed pressure roller assembly and head guiding assembly.

Mfr: Pentagon Industries, Inc.
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POLYPHONIC SYNTHESIZER

• The OB-Xa retains all the capabilities of Oberheim's OB-X, while adding a number of new key features. Highlighting these additions is a split keyboard function with programmable split location and balance, allowing one sound to be played on the lower half of the keyboard and another sound on the upper half. Also new is a doubling mode, allowing two sounds to be played with one key. Other features include two-pole and four-pole filters, programmable transposition of either half of the keyboard, improved noise generator, filter envelope generator, pitch modulation of VCO 2, and a hold footswitch. The OB-Xa is available in four, six, and eight voice models.



Mfr: Oberheim Electronics
Price: $4,995.00 and up
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MICROPHONE



• The Model AT815, commonly called a "shotgun" microphone, is a wide-range electret condenser microphone with a unidirectional polar pattern specifically designed for the narrow acceptance angle desirable for long distance sound pickup. The AT815 features a balanced, low-impedance output and a professional-quality cable connector. AT815 performance is achieved with a very thin (6 microns) polymer diaphragm whose low mass moves readily in response to changing sound pressure. The diaphragm is permanently charged, thus eliminating the exterior power supply of earlier condenser designs. Only a common AA penlight battery is needed to power the FET impedance-matching network built into the microphone. The polar response of the AT815 has been designed to provide excellent on-axis sound pickup with maximum rejection of sounds originating at the sides or rear. This narrow acceptance angle is achieved with a combination of gradient and line interference principles.
Mfr: Audio-Technica
Price: $200.00
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ROTARY-SLIDER ATTENUATORS

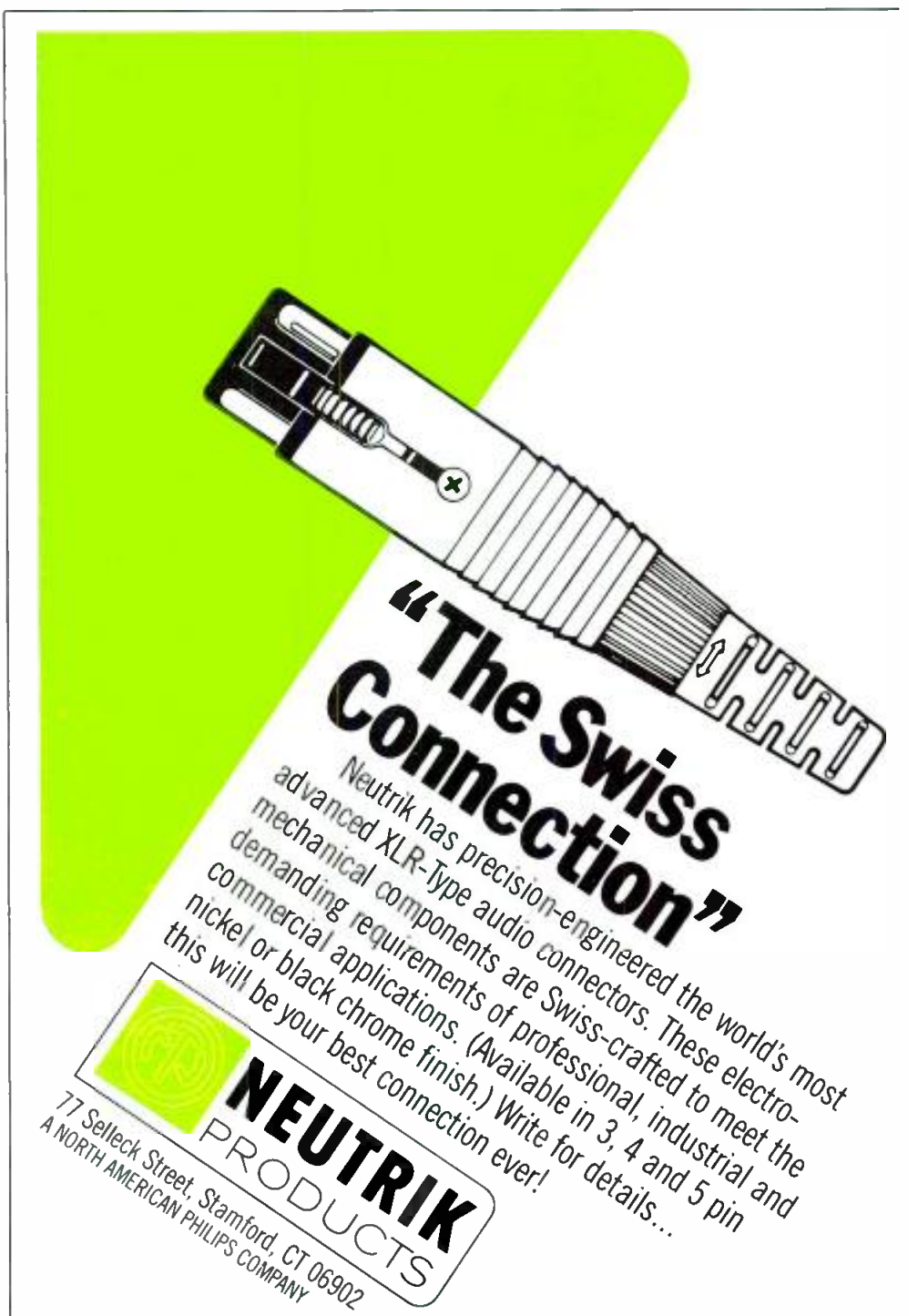


• New conductive plastic Rotary-Slider attenuators are available from Pro-Tech Audio Corp. The patented design features two sealed conductive plastic rotary pots driven by a slide mechanism. It is suitable for stereo or monaural fader applications. A cue microswitch is optional, and includes mixing resistors for deriving a mono cue bus from left and right stereo channels, while maintaining stereo channel separation of program channels. Standard impedance is 1000 ohms, which is ideal for most modern audio fader applications using I.C. Op-Amp circuitry. A 10k linear taper is also available standard for D.C. remote control applications such as VCAs.
Mfr: ProTech Audio Corp.
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PORTABLE PUBLIC ADDRESS SYSTEM

• Port-A-P.A., a newly designed portable public address system weighing only 36 pounds, has just been introduced by Womach Products. The heavy-duty fiberglass unit is powered by seven 6.7 volt rechargeable batteries and can be set up or taken down in a matter of seconds. Four built-in speakers assure quality sound and the system can be operated for a minimum of eight hours before recharging is necessary.
Mfr: Womach Products
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Have you heard the board

With digital recording that delivers 96 dB dynamic range, your board may be the noisiest component in your studio's signal path. If it is, you might consider replacing it with the new Auditronics 532 console with noise contribution so low it approaches the



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ıat's quiet enough for digital?

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db Editorial

IN DECEMBER OF LAST YEAR, we published a brief excerpt from John Eargle's forthcoming Microphone Handbook on Studio Microphone Techniques. The excerpt spoke about choosing—and then miking—the piano, as well as on mike placement for harpsichord and other stringed instruments.

You probably don't need us to tell you that control room hardware is getting more and more sophisticated. However, the other side of the glass is not being ignored either. Last month, we looked at some of the more-sophisticated electronics available to the studio musician. And now, let's take a look at a pretty sophisticated instrument that can be operated even during a power failure; the Bosendorfer Imperial Grand Piano.

This month, as we conclude our series on Music in the Studio, it seems like a good idea to take another look at the piano; a most-elusive instrument to record (or at least, to record *well*). Maybe it's just our imagination, but good piano sound is a rare commodity. Or is it the good piano that is the rare commodity? In at least some cases, perhaps the sound is actually *quite* good, considering the piano at hand.

It's getting to the point where, when a studio accepts delivery of a new 64 in/32 out automated board, it's not that much of a big deal. But when the same studio decides to take in a 9 foot-plus grand piano, *that's* news. No doubt this too shall pass, but for the moment, we thought it would be a good idea to look into the rationale behind such goings-on. And, as our story on the Bösendorfer indicates, a lot of industry leaders are spending a lot of time thinking about the music-in-the-studio side of recording. Our feature also includes some words on miking the piano—from the manufacturer's point-of-view, and we conclude with a few words of wisdom on keeping your ivory investment in good working order.

With world-class studios delving into digital recording technology, video systems, super-boards and high-priced pianos, studio rates are certainly not going to start falling soon. (Remember you heard it here first.) For the musician, this means that the fully-loaded studio is certainly *not* the place to go to rehearse for next week's session. What's needed is some space somewhere else, in which to be creative without going bankrupt. And so, we bring you "Creative Space," a Los Angeles answer to the time-is-money syndrome. Tom Lubin's eight-room complex (*un*-complex?) allows the studio musician to work out and get the tunes into shape, before moving on to the "big board."

Our January 1981 issue provoked at least some of the reaction we anticipated. Of course, we're speaking about the digital stress issue, which we actually should call something else, since we're still quite a long way from separating fact from fiction on this matter. We're amazed at how many people—who should really know better—are prepared to accept an accusation of "guilty" as though it were Newton's Fourth Law, and then go to considerable trouble to "explain" the cause of guilt. Sometimes, we think we'll just ignore the whole matter, until at least some of the heat is replaced by light. But then we look beneath the surface and discover how much we still have to learn about this whole matter of recording—and sometimes, even listening to—music. Perhaps this current tempest will be sufficient to get some answers to the questions we're just beginning to ask. We shall see. And by the way, note the frequent references to digital recording that appear in the piano story. Just a coincidence?

April is NAB (National Association of Broadcasters) convention time in Las Vegas (assuming there are still some hotels left there). To mark the occasion, John Borwick reports on a new broadcast console, manufactured in a distant kingdom, where broadcasters are all loyal subjects of a benevolent—though slightly daft—monarch known as "The Beebe." Of course, the kingdom couldn't be Great Britain. Everybody knows the BBC is a highly-respected organization whose brilliance and wisdom rivals our own FCC. On second thought, maybe it *is* Great Britain. Pity we forgot to ask. ■

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ROBERT CARR

Creative Space

Located in Los Angeles, Creative Space is a haven for the songwriter interested in working on his craft in a creative, up-to-date and easy-going environment.

AS INFLATION CREEPS UP and up, more and more people are feeling the squeeze in all areas of their business and personal affairs. This is certainly not a startling revelation. Inflation affects everybody sooner or later.

However, the entertainment business traditionally does well when times get hard. The consumer's need for escape from the drudgery and depression of his or her rat-race lifestyle leads to some form of musical song, dance or staged play in order to forget the problems of the day. Unfortunately, the profits derived form such placebos usually don't filter down to a large number of industry members, and the ones hit the hardest are the creative souls who have not yet made names for themselves—the people from whom new ideas will eventually spring forth to rejuvenate the industry as a whole.

The entire music hierarchy has gotten caught up in the quest for bigger, better and higher-performance electronics. Certainly these innovations, and in some cases quantum technological leaps, have made working in the studio much easier and more efficient, but no one should lose sight of the fact that it's the songwriter who started the industry in the first place. Without a good song, the most expensive state-of-the-art facility will not turn out a hit record. Ironically, everyone's employment depends on the very people who are being priced out of the market.

Engineer, writer, teacher-turned-entrepreneur Tom Lubin has pursued a new concept in composing and studio pre-production. It's a protective environment where the songwriter can get away from the pressures and constant interruptions of a home or studio situation, and concentrate solely on putting together a new composition in a stimulating, creative atmosphere, or work out ideas for a vocal or instrumental overdub before it's time to go back into that 48-track Buck Rogers world at $175/hour. It's a perfect rehearsal room for the pianist to record, evaluate, and clean up his technique before an important concert at the Museum of Modern Art; the only place where a publisher can make a cost-effective demo of a potential staff writer who's not quite developed enough to warrant a more expensive investment. Such a place could only be called Creative Space.

Robert Carr is a freelance writer working out of the Los Angeles area.

Creative Space is a small estate in the Wilshire district of Los Angeles (135 N. Parkview Street, L.A., 90026) that houses eight self-contained and user-operated recording suites. A suite is built around the new Teac Portastudio which is simple enough for any non-technically oriented composer/musician to operate after an initial get-acquainted period, and features overdubbing, variable-speed control, and Dolby noise reduction as well as a faster-than-normal recording speed (3¾ ips) for better signal-to-noise than standard cassette machines. In addition to the 4-track recorder, the custom designed console holds a Technics stereo amplifier, a Biamp stereo reverb, Roland's CR78 programmable drum machine, a Vector Research 2-track cassette recorder for mixdown, and a patch bay with two Auratone speakers mounted on top of the console. The control center is, in turn, mounted on heavy-duty wheels allowing the operator to position it anywhere in the room with ease.

Microphone selection encompasses quality models of the Electro Voice, Beyer and AKG lines. Yamaha headphones are supplied for cueing.

Finally, in the fine tradition of Tin Pan Alley, a regularly tuned Yamaha P202 console piano is included in the $12 hourly rate ($10/hour for cash). The only things the client has to bring are the ideas and any portable instruments like guitar, bass or synths that are needed to enhance the recording. No amps are required, because the Teac accepts the outputs of most electric instruments directly.

Creative Space is similar in concept to a McDonald's of the recording world—make the set-up complete, easy to use, and meet the overhead through volume. But that's where the similarity ends. The suites are of the highest quality design throughout, and a great deal of thought, planning, and hard work went into the construction of this composer's paradise. Space limitations, however, permit only the most general discussion of acoustic problems and solutions. (Ed. note: The author and Mr. Lubin are currently preparing an in-depth book detailing the construction of Creative Space which should be completed by the end of the year. The publication is aimed at the songwriter/musician who desires to construct a cost-effective demo studio in a spare room in his home.)

The structure was previously owned by the Wilshire Ebell Ladies Club. From time to time, members of the club might reside there, which means that what are now recording suites

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TABLE 1.

Room	Dimensions (approx.) L	W	H	Volume (ft^3)	Lowest frequency supported by room
1.	13.69 x	11.28 x	9.26	1,430	41.3 Hz
2.	11.42	10.71	9.26	1,133	49.5 Hz
3.	irregular		9.26	1,404	42.9 Hz
4.	14.00	7.41	9.26	960	40.4 Hz
5.	14.00	8.72	9.26	1,532	40.4 Hz
6.	9.65	9.65	9.26	862	58.6 Hz
7.	9.65	9.65	9.26	862	58.6 Hz
8.	18.5	12.46	9.26	2,135	30.5 Hz

used to be sleeping rooms. All opposite walls, floor and ceiling are parallel. Most rooms are relatively small (below 1500 cubic feet) and somewhat restricting, but nothing insurmountable in terms of acoustic preparation. F. Alton Everest was commissioned as acoustical consultant, because of his expertise in dealing with such environments. The following are his findings:

"The spacing of normal mode resonances of the rooms are excessive at low frequencies. In addition, the smaller the room dimensions become, the greater the bass deficiency below the frequency of the lowest normal mode." Alton's finding pertaining to room size and corresponding lower limits are given in Table 1.

Note that only two or the rooms (5 and 8) are above the 1500 cubic feet in volume. The six rooms below this volume are especially subject to colorations resulting from acoustical flaws. The lowest frequencies supported by the rooms vary by almost one octave (30.5 to 58.6 Hz).

A study of the distribution of the axial room modes helped to identify those frequencies that were most liable to cause problems, and these are listed in Table 2.

"For the reverberation times of the rooms, the effective bandwidth of each mode is about 8 Hz. Therefore, room response will be down when a gap greater than 8 Hz is encountered, or up if the bandwidth of several modes overlap," says Alton. "Because these are composing rooms, there was a certain degree of uncertainty as to the best reverberation times. Although 0.4-0.6 second was considered at first, it was decided that room flaws would be less noticeable if heavier absorption and resulting shorter reverb times were used." For example: in room two, 0.25-0.3 second was the goal. (See floor plan for room layout.)

The closets in all the rooms were turned into either slat resonators or helmholtz resonator bass traps. Some rooms required both, in which case the closet was the slat resonator and the helmholtz was attached to the wall. Five-eighths inch Gypsum board was first cemented to the plaster inside the closet, and the seams were sealed with caulking. Those resonators intended as broadband absorbers utilized Johns Mansville Series 1000 high density fiberglas. Owens Corning 703 fiberglas was originally chosen to stuff the bulk of the closet space, but Series 1000 was substituted when it was discovered that the acoustic properties of both are very similar, and the Johns Mansville product is substantially less expensive.

The construction team took full advantage of the unique layout of the building. Where two closets separated adjacent rooms, Rockwool was blown in them to insure that no sound would travel through that section.

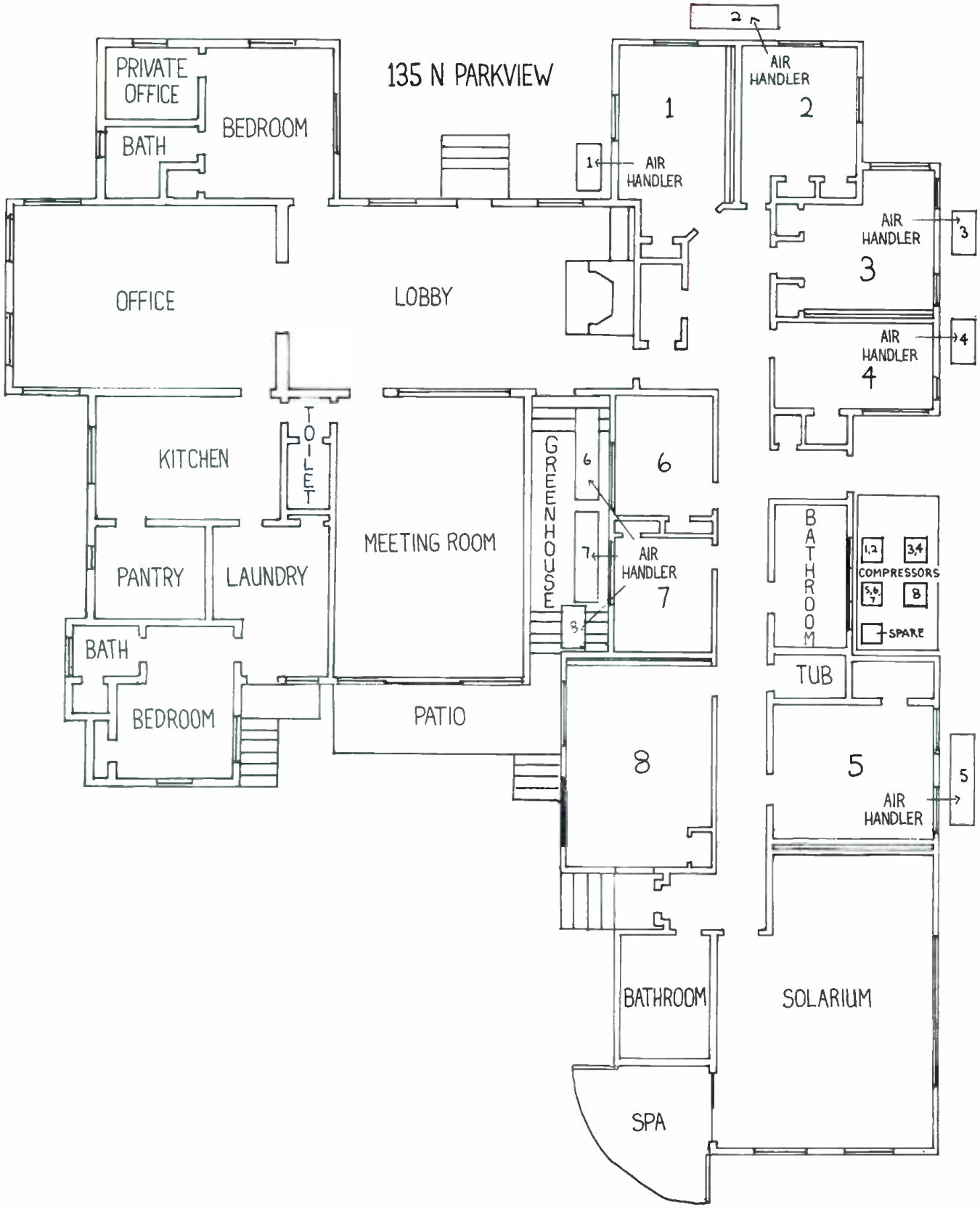
All existing doors were replaced with solid-core doors with weatherstripping around the perimeter. Sheets of Series 1000 were placed on the inside surface of the door to cut down sound transmission. Additional absorption was obtained by

TABLE 2.

Room		Remarks
1.	122 Hz-124 Hz	
2.		Fairly clean.
3.		A 13'2" step reduces mode spacing.
4.	121 Hz-122 Hz	
	242 Hz-244 Hz	
5.	121.5 Hz-122.2 Hz	
6. & 7.	61.1 Hz- 62.1 Hz	The almost-cubic proportions degrade
	122.2 Hz-124.2 Hz	the acoustical quality.
	244.3 Hz-248.4 Hz	
8.	61.1 Hz,122.2 Hz	The 2:1 relationship between length
	183.2 Hz,244.3 Hz	and height creates problems. Helped slightly by an added wall.

(note: 122.2 Hz is the second harmonic of the vertical axial mode.)

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Floor plan of Creative Space.

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hanging cotton draperies (the thickness of the drapes varied from room to room) from floor to ceiling on one wall of each room, usually over the resonator. These were spaced either 3.5-inch or 10-inch from the wall so that they would trap specific pitches and balance out the room.

Common walls presented serious questions in terms of leakage between adjacent suites. A somewhat effective solution meant erecting a second wall one inch from the existing structure and this was supported by a base of Celotex. Starting at the wall and proceeding towards the center of the room, the new partition consisted of the one-inch air space, which was eventually filled with Rockwool, 2 x 4 framing—16 inches on center—with 3.5-inches of Owens Corning R-11 between the studs, a layer of ⅝-inch sheetrock caulked along the entire periphery, and an outer covering of 4' x 4' sheets of Sonex foam—two pieces high and three pieces lengthwise—in a checkerboard arrangement of positive and negative patterns. All Sonex and draperies were treated with fire retardant.

In severe cases of sound transmission through a common wall, sand was poured between the studs in the connecting section through an access hole drilled outside the building. This increased density took care of whatever leakage remained.

Floors were floated and heavy carpet and jute were installed. The windows remained unaltered except for large sheets of plexiglas that were sealed into the window frame on the outside of the building. This procedure created a double-paned effect, similar to that found between studio and control room in conventional recording environments.

Making the hallway highly absorbent has helped in attenuating the noise from room to room via the hall path, and tends to reduce hall traffic noise as well. Carpet alone seems to be quite sufficient, but additional insulation may be added to the walls at a later date.

The concept of "Space" is such that the only live sounds in the rooms are the vocals—which are easily absorbed by the previously discussed acoustic treatments—and the piano—at that point, still a matter of concern. Isolator pads were placed under each caster to eliminate the possibility that the bare caster alone would push through the carpet and effectively rest directly on the floor. The isolators consist of a sandwich of two one-foot plywood squares with a center of rubber and cork. Five decouplers were used per pad, and four pads per piano. With an approximate weight of 800 pounds per piano, and 200 pounds per caster, the isolators reduced the pressure on the floor to about 1.38 pounds per square inch. A foot rest as high as the pads was positioned beneath the pedal section of the piano to compensate for the added height.

All air conditioning is supplied by eight separate air handlers and four compressors. The practically noiseless handlers were installed directly outside the rooms they were intended to cool or heat (numbered boxes 1 through 8 in FIGURE 1), while the compressors were congregated in the section outside of the rest rooms in order to eliminate the chance of hum or rumble showing up on a client's demo. Oversized and well-insulated ducting and plenums were necessary to slow down the air pressure, yet keep the volume of air at its maximum. A four-hundred amp service was installed to power the complex's air conditioning, electronics and living quarters.

Lubin's philosophy encompasses more than just keeping the rooms quiet, temperature controlled, and trouble-free. All of those features are to be expected when someone rents a recording suite. It's the extras that make the difference. "After all, this is called 'Creative Space,'" says Lubin, "and we have to live up to its name. I think more important to the songwriter is the feel of the environment. We've gone to great lengths to keep the lawn, garden area, and fruit trees lush and in good health. The fountained grounds are maintained with the point of view that clients can relax, picnic, and/or contemplate their newest creation in a natural setting. We have two lounge areas. One is primarily a meeting room with couches, color TV, and complimentary refreshments where songwriters of varying abilities and experience can converse and exchange ideas. The other contains guest storage lockers, permits access to the solarium that houses the whirlpool, and offers a view of the garden and the Hollywood Hills."

The west wall of the lobby is home to a large, operable stone fireplace for cozy conferences around the fire on chilly evenings.

More pragmatic in nature is the cassette and reel-to-reel dubbing room that can make up to six cassette or two 2-track transfers at a time.

Each suite is decoratively finished, and furnished with a fold-out Futon bed (which can, in a pinch, double as a gobo when placed on its side) and other boarding house accessories. Lengthy block-booking rates include a free home-cooked meal each day and transportation to and from the airport when necessary.

So far, business is brisk, and more than a third of the patrons are on their second, third or fourth visit. Musician/songwriter Gary Evans summed up the essence of "Space" best when he said, "The equipment is top notch, and the attitude of the people who run the place is to make you as comfortable as possible. I'm able to do exactly what I want to do. There's no engineer between me and the board. That way I directly control the sound that comes out in the final mix. What more could you ask for?" ■

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db Special Report

The Digital Controversy, Continued

THE RESPONSE TO Dr. Diamond's article in our January issue—and our postscript to it—has generated so much reader interest that we present this "post-postscript," in which we offer everyone a chance to share their thoughts on the subject.

Bob Campbell's thoughtful letter provides us with a splendid introduction to this continuation of the digital discussion, for it allows us to clarify our own position (or lack of one).

TO THE EDITOR:

I'm somewhat distressed by two of the articles appearing in your January 1981 issue. They are, as you might have guessed, "Human Stress Provoked by Digitalized Recordings" and "A Post-Script on Digital Stress."

I enjoy reading ***db*** *very much and although I'm not an engineer, I find most of the articles enlightening. In effect, I consider* ***db*** *to be a source material for new techniques and products.*

What bothers me is that you allowed Dr. Diamond to present his case, and then blasted his article with one of your own. I would think that in order to appear in ***db*** *the article should be credible to begin with. What is the point of presenting something only to denounce it by the same people who printed the article in the first place? Cheap shot.*

I get the feeling that I won't be able to read the articles in ***db*** *without expecting to get a contrasting view on the next page.*

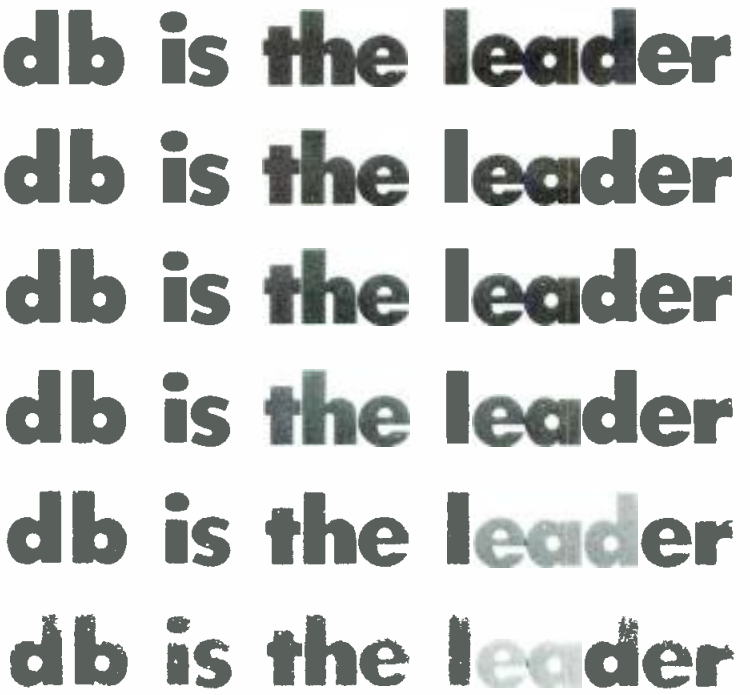
It should be, in my opinion, your responsibility to judge if an article is acceptable for publication and then let your readers make the comments concerning its validity.

In your defense it should be noted that you did state that you normally don't write the kind of post-script under the heading of "Special Report" that appeared in the January issue. Also, you said that you felt that many readers take what appears in print as gospel. Could be, but by publishing both articles you have assumed the position of both defendant and prosecutor. Is this something that I can look forward to in future issues? I hope not, ***db*** *is a fine publication that I have turned to in the past many times for information and I hope I can continue to do so.*

BOB CAMPBELL
Operations Manager
KCCY-FM

More often than not, **db** does try to stick to the facts. We feel that readers expect our writers to provide practical and accurate information. And, neither we nor you appreciate

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being "taken down the garden path" (a technical term for B.S.) by an author's personal opinions being offered in place of those facts.

Most of the time, this works out very well. For example, most of our regular coverage of digital audio sticks to the facts. Barry Blesser's column, and Sidney L. Silver's articles are excellent examples of this. However, when an author works for a manufacturer of digital tape recorders (or any hardware for that matter), it is possible to present another type of information.

For example, it is a fact that Company X does things *this* way, and Company Y does things *that* way. Tape format is an obvious example. Some prefer open reel, while others use a video cassette format. The "correct" format is still a matter of opinion, and we must take care that our authors do not "inform" us that their format is the only proper one. Rather, they must tell us why they prefer doing it their way, and let us (that is, you the reader) make the final judgement.

In most cases, we therefore try to balance an article on method X with another on method Y, to give you enough information to make up your own mind.

Getting a little closer to the issue at hand, we'd like to think that if an entirely worthless article comes our way, we would not annoy our readers by printing it, and would certainly not waste even more space by refuting it in a postscript.

And that brings us up to this A-D controversy, and our role as defendant/prosecutor. It is our *opinion* that most manufacturers of digital hardware will not respond to Dr. Diamond's comments. Nor perhaps should they, for if we are seen as the D/P in this matter, then Dr. Diamond appears to be the judge (self-proclaimed) who has ruled that digital technology is "guilty" as charged (by himself). It would no doubt be inappropriate for digital technology to dignify the charges by defending itself.

Yet, almost every magazine from the "underground" press to the high-end audiophile monthlies has had something to say recently about the sound of digital technology. And although **db** does not reach the record-buying public, it certainly does reach the record-*producing* public, many of whom are investing —or thinking about investing—in a digital future. Well, many of us read the hi-fi press, and see those often unfavorable comments on digital sound. Then, along comes Dr. Diamond, implying that "objective physiological scientific" tests reveal digital stress. Well then, let's get OSHA after those digital demons, and we'll all go back to good old analog.

Not so fast! Have we learned *nothing* from history? Has there *ever* been an invention that was not born into a hostile world? So before we all go charging off on the digital-stress bandwagon, let's think about this for a while. It's unfortunate that the controversy has taken on aspects of a carnival sideshow, but at least Dr. Diamond has succeeded in getting everyone's attention, and we're beginning to see some very interesting ideas emerge. As an example, consider the following letter:

To The Editor:

I'm not a kinesiologist. I'm not even a doctor, much less an engineer. Despite this lack of educational credentials, I have some thoughts about the claims for increased stress based on the trauma of listening to digital recordings.

While increased stress is generally regarded as "bad," it may be the appropriate reaction to some stimuli, and—in that sense—it might be possible to regard increased stress as "good." The clinical use of recorded music as therapy to reduce stress might predispose one to suggest that if this therapeutic result cannot be obtained with digital recordings, there must be something "wrong" (i.e. stressful) about the digital process.

But may I suggest that this may be the wrong comparison? Rather, I would suggest that the stress reactions for both types of recording (analog and digital) should be compared to live *music to see what correlation (or lack of it) can be achieved.*

The primary goal of recording is rarely therapeutic. Rather, most recording is an attempt to create the live music experience. It may be that the lack of stress response to analog recordings is, in fact, proof that it is inferior to digital recordings rather than the opposite assumption based on this type of clinical result.

We shouldn't condemn a process on the basis of its inability to serve a narrow purpose neither contemplated nor intended by the record maker.

Lloyd W. Loring
Vice President
J. G. Sullivan Advertising, Inc.

Well, some of us might argue that most recording is *rarely* an attempt to create the live music experience, but rather a new art form which sometimes simulates live music but more often doesn't. If you'll buy that, perhaps it is the superiority of digital that finally allows us to hear how wretched some of our cherished recording techniques really are. Now wouldn't *that* be stressful?

Other readers offer various explanations for Dr. Diamond's "findings." We've got mixed emotions about pursuing this tack, since we keep reminding ourselves—and our readers—that before a "fact" can be explained, it must first be identified as such. So far, no one (and certainly not Dr. Diamond) has done this. So, although we still don't have any "facts" to explain, we are getting some interesting questions. For example:

To The Editor:

The article on digital recording stress by John Diamond and your post-script in the January 1981 issue was most interesting. In your post-script you came just short of making what I think might be a very significant point. What stress level is produced by a live performance? Is it possible that analog recordings, as a result of their subtle distortions, reduce the stress (and fidelity) of a live performance? If so, it may be that the greater fidelity of digital recordings merely reproduces "stress-inducing factors" which are there in the first place.

It seems to me, then, that comprehensive tests such as you propose should also include live performances.

Jacob Z. Schanker
Chief Engineer
Scientific Radio Systems, Inc.

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We invited Dr. Diamond to respond to our January postscript, and to Mr. Schanker's letter:

TO THE EDITOR:

Thank you for your careful attention to my work on stress provoked by digital records. Let me emphasize that the testing technique employed has been in use for many years. Among other clinical applications, it has been used for the identification of many stressful stimuli in the environment, of which "digital" is but one. It is not a subjective test; it is not influenced by the tester's or subject's preference for either the recording technique employed or the work performed. This is an objective physiological scientific test.

At the Los Angeles AES meeting last May and on many occasions subsequently, I have stated that it is very easy to overcome the stressful effect on playback of digital records and that I was happy to pass this on to the industry. So far no response has been received.

In reply to Jacob Schanker's letter: Within the testing parameters under discussion, no stress is provoked by live performance of classical music. Further, it is difficult on testing to discern the difference in results between a live performance and an analog recording of it. Whilst his suggestion is indeed interesting, it is not in keeping with our findings.

For additional information on live performance and other music-related matters, Mr. Schanker may wish to read my recent publication, "The Life Energy of Music: Notes on Music and Sound," available from the Institute of Behavioral Kinesiology, P.O. Drawer 37, Valley Cottage, NY 10989.

JOHN DIAMOND, M.D.

We were surprised to read that Dr. Diamond had "...stated it is very easy to overcome the stressful effect on playback of digital records...." In fact, in his January article right here in **db**, he called for a joint research project to work on the "problem," which would seem to imply that even he had no definitive answers at the moment.

Paraphrasing our own January postscript, we hope that something constructive may eventually come out of all this. Towards that end, we proposed a scientific inquiry into various aspects of music engineering. And let's repeat that such an inquiry must be set up to uncover truths, and not reinforce expectations.

For example, in a recent Syn-Aud-Con newsletter, Don Davis reports about some experiments at the Harvard Medical School. According to the late Dr. Henry K. Beecher "Patients suffering from angina pectoris were given sham arterial bypass operations. They were merely cut open and sewn up. But the patients generally expected the operation to improve their condition, and, in fact, they did as well as patients who were given real bypass operations."

Incredible, but no doubt true. The patients were preconditioned to expect certain results, and so they experienced what they expected. It happens all the time. Isn't that what happened at the AES convention, when Dr. Diamond told his "patients" what they would experience, *before* the tests began?

If we are ever going to learn anything from scientific inquiry, we must not go into our audio "operating room" with the expected answer already in our head. However, we can't resist offering this unscientific thought: what if we eventually discovered that—at last!—digital technology is capable of faithfully capturing *all* the joys of music, including its tension and stress? Maybe we'll know the answer to that one after some tests, but probably not before. And speaking of tests:

TO THE EDITOR:

*We were very pleased to read your proposal in the January issue of **db** magazine that the University of Miami be selected as a testing site to evaluate some of the recent controversy regarding digitally-produced stress. We would be very pleased to host such a study and agree with you that our program offers many advantages which would make it an ideal forum.*

As you noted in your editorial, solid evidence is needed now, not mere argument. To that end, we would be very concerned to insure that a stress study be rigorously conducted and the findings soberly published. Of course we are not interested in media events or short-lived publicity of excited crank claims. Also, we doubt whether one study could conclusively prove or disprove the question of stress. We could only offer a subjective test initially; ultimately the last word would rest with the scientific community.

Thus, we are very anxious to host a fairly-conducted study designed to test digital stress. Manufacturers and investigators could work together to help find evidence which would only benefit sound recording and reproducing technology. We are ready to collaborate with you to organize this study. Certainly the first step would be to consult impartial specialists in the related fields and draft appropriate methods and procedures for testing.

We are excited about the possibilities of this project and appreciate your announced confidence in our program.

BILLY PORTER
KENNETH POHLMANN
Directors
School of Music
Univ. of Miami

Perhaps this brings us back to Bob Campbell's letter. We think that contrasting views on matters of opinion do have a place in **db**. Only by giving both sides a chance to speak can the reader make up his own mind, or at least form an opinion. It does no one any good if these pages offer only one side of a controversy.

Since January, we have twice made space available for a definitive statement on digitally-produced stress. In our opinion, no such statement has been forthcoming. Our conclusion is, therefore, that no such statement (*with* proof, of course) is possible. However, our opinion is certainly not cast in concrete, and we'll try to keep the dialogue going for as long as there is sufficient reader interest, *and* something worth saying. ■

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ERIC JOHNSON

Now That We've Got It, What Do We Do With It?

MOST PEOPLE ASSOCIATE the concert hall with the piano when thinking about the most critical usage of the instrument. Although the picture of the massive grand on the stage seems indelibly imprinted in everyone's mind as the most demanding environment a piano could be found in, the concert hall is actually very forgiving. This spirit of forgiveness is due to the huge space, environmental noise, absorption and especially the fact that each note is heard by the audience only once, and even then it is tempered by the (hopefully) magical experience of hearing live music. When these factors are compared to those found in the studio, it seems that the latter is actually the more demanding environment.

Due to its massive weight and construction, the piano may appear to be an indestructible blunderbuss, capable of withstanding continued hammering with hardly a whimper. The fact is that the well designed and constructed piano *can* withstand continued hammering, but care and attention must be routinely paid to keep the whimper from becoming a full fledged bellow.

Careful consideration must be given to different factors when choosing a piano for studio use. These considerations include what the recording process does to piano sound, the inherent characteristics of different makes and perhaps most importantly, a realistic concept of what a piano can and cannot be expected to do. If you have proceeded with the pre-purchase process carefully, you will have an instrument with which you will be very happy for a long period of time, provided you consider the post-purchase process just as carefully.

I have chosen to present the post-purchase point of view in a series of exploded myths.

MYTH 1: The piano is indestructible.
This is often closely associated with
MYTH 2: You can't play a piano hard.

Neither of these are true. Consider the components. For each note there are 10 moving parts, 14 felt or buckskin surfaces that contact wood or metal, 11 specific regulations, and 7 points that impact forcefully enough to cause a noise. This does not include a number of relationships in the overall instrument, such as pedals, string levels, etc. With each key stroke there are factors of friction, compression and vibration at work, throwing the action components out of their mathematical optimum relationship. This wear, compression and misalignment must be regularly compensated for by re-regulating the various mechanical aspects. It is more advisable to touch-up regulate on a regular basis rather than court disaster by infrequent attention to mechanical details.

Eric Johnson is the National Piano Service Manager for Kimball and Bösendorfer, as well as an active composer and pianist.

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The other side is when one considers the force transferred and multiplied between the finger and the strings, coupled with some of the tremendous demands of the repertoire. Actually, it is amazing that we can get a series of notes to play in succession at all, much less bear the brunt of a Prokofiev sonata. The astonishing flexing and bouncing of the wood action parts is especially evident when viewing high speed films of single note models.

MYTH 3: The better the piano, the less care it will require.

Emphatically false, for as in any high quality design, its tolerances are kept very close, and only by strict adherence to these tolerances will it keep functioning at its true capacity. The high quality piano will respond to extra care and feeding in the form of sensitivity and durability as opposed to the lesser quality instrument that usually requires the same amount of effort just to break even.

MYTH 4: "It shouldn't be out of tune, we haven't used it for (hours, days, weeks, years)."

This is false because playing is not the major reason a piano goes out of tune. One of the qualities of the steel in piano string is that it is marvelously elastic (though, according to some, not quite enough so for tuning purposes, but that is another story). The string experiences great displacement as it travels from the tuning pin to the hitch pin, and must rebend around all those contact points every time it is tuned. This is to say nothing of the tremendous distortion the string experiences at hammer impact. But the same elastic qualities that allow it to survive this distortion also carry the inevitable side effect of stretching. One of the major reasons for tuning is to compensate for this continual stretching. When you realize that a good tuner will be tuning to tolerances of 7/10ths of one cent, you realize that it does not take long for a piano to go out-of-tune. (100 cents = 1 semitone—Ed.)

The humidity levels of the surrounding environment also play a direct role in tuning stability since the strings are attached to the soundboard through the bridge. Therefore, any rise and fall of the thin soundboard as it responds to changes in humidity levels will directly affect the tension of the strings and therefore the tuning. For this reason it is generally more important to maintain constant humidity rather than temperature levels, though consistency in both is important to the well-being of the instrument. A general industry standard is 40 percent relative humidity and a temperature range of 65 to 75 degrees. Low humidity is usually considered more detrimental to pianos, as the resulting shrinkage can cause splits and broken glue joints. Simply keeping the humidity above 40 percent is usually sufficient, provided that high-humidity excursions do not happen too often.

Aside from compensating for stretching and humidity fluctuations, tuning is also a process of rearranging and evening out the 40,000 to 50,000 pounds of tension acting both laterally on the plate and vertically on the soundboard. A stable tuning is the result of careful and minimal change in the stress. Frequent though small adjustments of string tension are tunings that will be stable and durable. If you find yourself asking the question "What's the use of a durable tuning if we're tuning it all the time anyway?", consider the importance of a piano sounding as good at the end of a session as it did at the beginning. This durability will not be achieved by one of the three-times-a-year tunings shortly before the session.

Pianos are truly wonderful instruments responsible for a great deal of what we know as western music. Not only are the skills of piano manufacurers greatly increasing, so too are the skills of the collective technical community. The selection of a piano technician and subsequently allowing him to practice his or her skills at the highest level will be as important to your ultimate satisfaction with your piano as is the careful initial selection of the instrument. With some attention to detail, the world will be a better place for pianos, and therefore, better for all music lovers. ■

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JOHN WORAM

A Musical Investment

Some thoughts on piano acoustics and the Legendary Bösendorfer Imperial Grand.

EACH YEAR, the Audio Engineering Society holds three conventions at which the latest in recording studio hardware is featured in the exhibit area. Obviously, it is *the* place to go to see all that's new, from microphones to monitor systems. The phrase "recording studio hardware" conjures up visions of super-boards, automation systems, digital electronics, and all the odds-'n-ends that go into the state-of-the-art studio. But recording studio hardware can also mean musical instruments; for without them, why bother with all that other stuff? Of course, some musical instruments come and go with their musician/owners, and it is unlikely that any studio will have on hand a supply of violins, trombones and such. On the other hand, drum kits and guitar amps are a part of almost every studio's equipment inventory, and so of course is the piano.

The studio piano has often been an instrument of dubious virtue. World-class pianists usually bring their own, or rather, a prominent piano manufacturer sends one in for the session, in return for a credit line (better yet, a photo) indicating that the artist *always* uses the brand X piano.

The less-than-world-class pianist has to make do with the in-house keyboard, which may be anything from an upright tossed out by the local high school as unplayable, to a very used concert grand that has seen and heard better days.

Figure 1. One Bosendorfer, going up!



John Woram is the editor of db magazine.

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Figure 2. At Sound 80 Studios in Minneapolis, chief engineer Scott Rivard gets ready to record the Bösendorfer for the new Sound 80/3M digital "Spaces" album.

As noted, the really first-class instruments are quickly wheeled out of the studio, almost as the reverberation decays past the RT60 mark. But then, a year or so ago, some pianos began showing up at the AES conventions, competing with all the other studio hardware for a piece of the studio owner's equipment-budget pie. In fact, no less an instrument than the legendary Bösendorf Imperial grand could now be found on display.

Unless you've been a house guest of the Ayatollah Khomeini for most of your adult life, you'll recognize this as the instrument that most pianists only fantasize about owning. It costs a trifling $50,000+, and takes more than one year to build.

Apparently, the Bösendorfer people actually thought that recording studio owners would be willing to part with the necessary bucks to bring these 9'6" monsters into the studio. Apparently, they were right. And although the Bösendorfer is not yet on *every* studio owner's wanted list, more and more are beginning to show up around the country, as one studio after another succumbs to that Bösendorfer sound.

We decided to do a little snooping, to answer a few questions that were nagging us. For instance, does a rock session *really* need a 50 kilobuck piano? Will it hold up under the abuse of day-to-day life in the studio? What about miking techniques? And so on.

Our first stop was at Universal Recording Studios, to ask Murray Allen about his decision to acquire a Bösendorfer. According to Allen: "The important thing is to get the performer to want to play better. That's why we spend so much time with ambience of studios, lighting, nice woods and attractive drapes. It has some acoustical benefit, but more importantly, it makes the artist feel like he wants to play. The Bösendorfer's extra keys (97) give it a much, much better-sounding bass. Stereo miking on this piano is a snap, because you hear so much stereo standing next to it. Normally you don't get that separation, because in other pianos the bass doesn't sing out. In rock playing, it's often difficult to balance left-hand and right-hand parts, because of most pianos' inability to speak with equal apparent loudness. Our Bosendorfer eliminates this problem.

"We have just installed 3M digital equipment, and when I hear the Bösendorfer from digital playback, knowing its sound live, I hear all the richness and fine detail. The Bösendorfer is right for nearly any idiom; we've done things from rock to opera with it, and it's very sought-after."

Amelia Haygood, president of Delos Records notes that the piano is "...less like a percussion instrument, and more like a stringed instrument; like a rich double bass or cello. The strings cross over at a musically very satisfying point, analogous to the selection of crossover points in loudspeakers. The sound holes are larger, for freer escape of tone."

At San Francisco's Sonic Arts Corporation, Leo de Gar Kulka talked about pianos and miking techniques. "Based on my many years of recording experience, I had been agonizing over how I would mike the Bösendorfer in my studio, which measures 40 x 50 feet, with a 20-foot ceiling. To my astonishment, just about any place in the room where I would put the microphones, the piano sounded "right," and it was only a matter of deciding the perspective the music demanded. You cannot consult the pianist, because he/she hears the piano from a perspective no one else hears. The right position turned

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out to be about 12 feet away from the piano, with the mike about ear-level and pointed to the raised cover so that the reflected sound, direct sound, and ambience blended properly. That was where the piano sounded best to the "naked ear," and therefore it was not surprising that it sounded best to the microphone system. I used the AKG C-24 stereo microphone in the sum/difference mode. At one time I brought in two Neumann M-49 condensers spaced 6 feet away and 10 feet apart, with a PZM under the piano, and got a stupendous sound. Later we discarded those takes as 'hokey' and dishonest, though they would have sent some hi-fi bugs to 'audio heaven.' In rock or jazz, such techniques make great effects. The recording came out very well. We recorded it on PCM, and are just in the process of releasing it.

"I have had every make and size of grand piano brought into my studio and found that there is no 'formula' for getting a sound, but rather that I crawl over and under the piano, wander about the room, stick my head into the piano, listen to the sounding board, until my ear tells me that I might have found the spots where the blend of primary and harmonics develop the most complimentary sound. I note these positions in my mind, and then start placing numerous microphones. Next, I go into the control room where the monitor volume is adjusted so that when the meters read zero, the sound pressure is about what it was in the studio. I bring up the various mikes, first one at a time, then two at a time in combinations, until I have the sound I want—what I hear outside.

"The most revealing experience was my recent session with Mr. Stephen Kates, who plays the famous Mantagna cello, also known as the X-Hancock, made in 1736. It used to belong to maestro Piatigorsky. You must hear the sound to believe it. I miked the cello with a Neumann M-49 in the cardioid mode, about 10 feet distant from the bridge and at a 90-degree angle to the surface of the cello. The cellist, on a platform, was facing the pianist in such a manner that he could observe her hands. The piano projected into the 50-foot length of the studio, and was miked with one Norelco condenser mike approximately 6 feet high and 10 feet away from the bend in the piano. The other matched Norelco was about 5 feet high, 6 feet away from the body of the piano, in line with the bass notes. A third microphone was placed about 20 feet away, but it had a tendency to 'mush' the sound, so we discarded the idea. I moved the mikes slightly until a proper positive phase relationship was established, and a proper voicing over the entire scale. From that moment, we neither moved volume controls nor mikes for the two days we recorded. The record is on our Sonic Arts label.

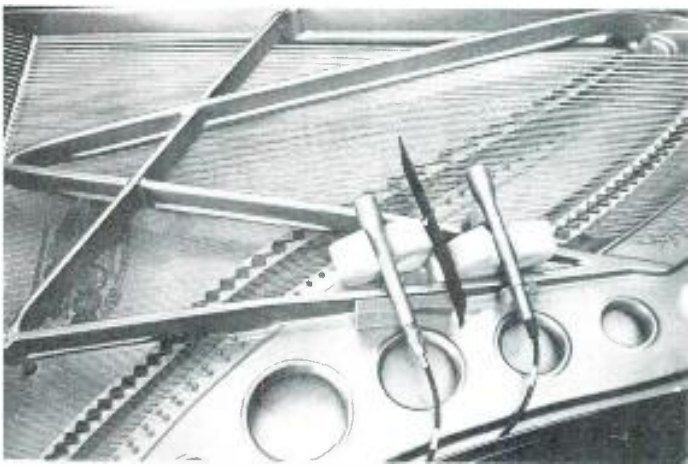


Figure 3. At Acme Recording Studio, Mike Rasfeld often uses the setup shown here. The microphones are Audio-Technica's AT 801.

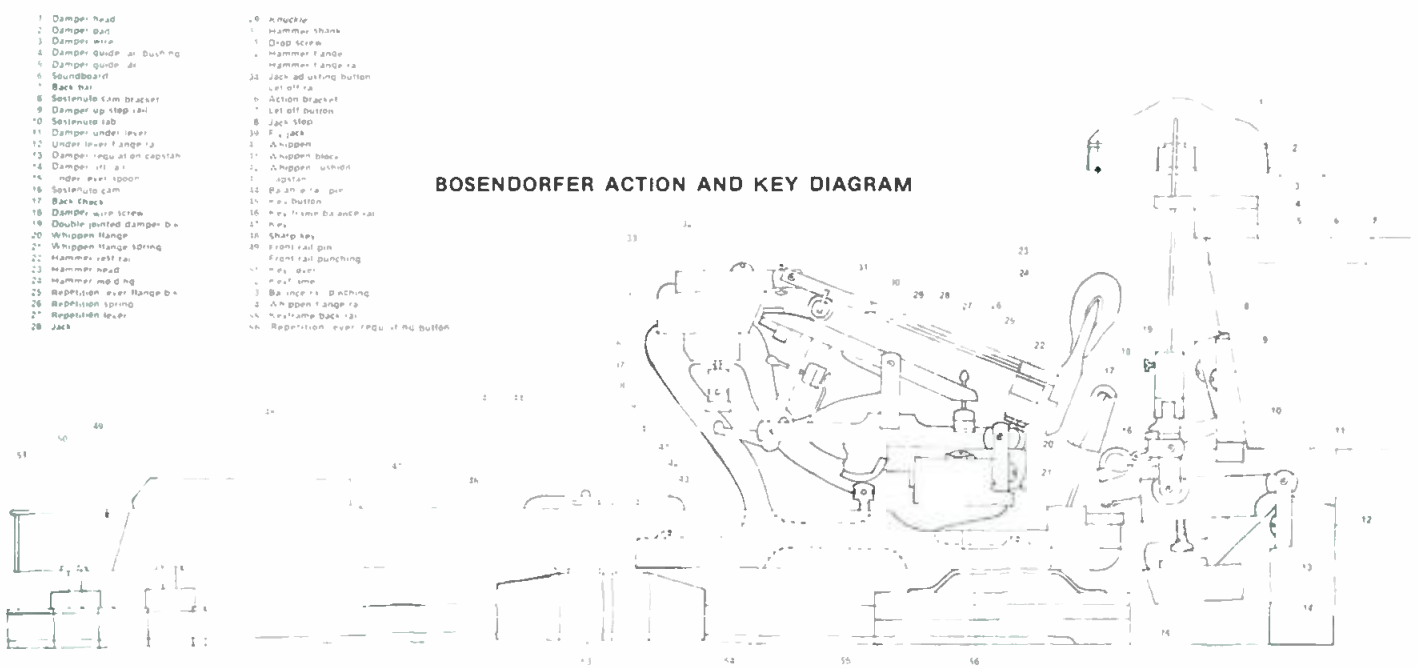
It's a digital recording, which gives us the truest sounds we have ever been able to reproduce from a sound storage medium."

Sound 80 studios in Minneapolis are among the pioneers in digital recording, using the 3M system. In the digital album "Spaces," producer Herb Pilhofer uses his Bösendorfer as both a solo instrument and an effects generator. In "One Day at a Time," a piano solo with lengthy sustaining notes leads into a saxophone solo surrounded by an ethereal, liquid reverberation. The sax was played into the open 9'6" piano, with the dampers lifted, so that the piano would follow and enfold the saxophone in a "sunken cathedral" ambience.

MORE NOTES ON MIKING

According to Universal's Bill Bradley: "Pianos are always tricky to deal with. Usually I close-mike, since there's a lot of leakage. I usually use a stereo mike 6 inches to 10 inches up, behind the hammer line, aimed at the hammers. This gives a good percussive sound, but with lots of tone. An alternative is three mikes across the hammers and one in the bass end. Phase coherence with this setup is delicate. The mike in the bass end is panned full left and the other three are panned left, center and right, as they are placed. I get good isolation this way; outside sound is overwhelmed, and the bottom-end mike helps the lows that aren't heard near the hammers."

Figure 4. "Actually, it is amazing that we can get a series of notes to play in succession at all." Some 56 mostly-moving parts are required for each note on the keyboard.



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Figure 5. A close-up of the voicing process, best handled by a skilled piano technician.

Stan Ricker is chief engineer for Mobile Fidelity Sound Lab, Inc., and has worked on a number of Bösendorfer/digital recordings for both Telarc and Delos Records. Recent projects have included "Water Music of the Impressionists" for Delos, and Telarc's "Malcolm Frager Plays Chopin." Stan reports that: "In both the Telarc and Delos projects with the Bosendorfer Imperial, we used the Soundstream digital recording system. The Telarc disc was miked with two omni B & K condenser microphones (capsule 4134 which is flat for random incidence), and B & K preamplifier 2319S. For the Delos album, we used the same mike set-up with a specially-constructed low-noise, low-distortion power supply, and line-driver amplifiers designed and built by John Meyer of Meyer Sound Laboratories, Inc. In both albums, the microphones fed a Studer model 169 stereo mixer."

On a Kimball 6'7" piano, which is based on a Bosendorfer design, Mike Rasfeld (Acme Recording Studios, Chicago) has developed some unusual miking techniques. "We have tried coincident and near-coincident AKG C-12As, Shure SM-81s, PZMs and Sony ECM-51s acting as boundary microphones against the underside of the lid, and even a Sennheiser 415 shotgun over the right shoulder of the pianist, mixed into the pairs. Each technique has characteristics that are helpful for different purposes: pop, rock, classical, jazz—each having different demands on the illusion created. One unusual method is illustrated in the accompanying photo (FIGURE 3). It shows two Audio-Technica AT-801 omnis, spaced 5 inches apart with a cardboard sheet in between. There's a spot to be found between the treble and bass bridges where the notes will move chromatically across the stereo spread. The slightest tilt can make a big difference, but it's worth the time to find it. Once set, the keyboard will be spread evenly left-to-right. It's not appropriate for everything, of course, but it's a convincing illusion. This also works with the lid closed, but care must be taken to keep the mike diaphragms as close to the lid as possible to avoid multiple paths. With the top down, we suck some 200 Hz rather broadly out of both mikes. The result has been an amazingly good piano sound without enclosing or isolating the piano, even with loud rock drummers or full-blown big bands in the same room."

Since every studio, and perhaps every studio engineer has a favorite microphone technique, we asked Bosendorfer's Wade Bray to pass along some general comments about piano acoustics which may be of interest to the studio engineer looking for ideas towards a better piano sound. In addition to representing Bosendorfer and Kimball pianos to the recording industry, Mr. Bray is active in piano acoustics research with Kimball's R & D division. He was formerly a chief engineer of Swartwout Productions, Inc., in Scottsdale Arizona, and has experience in production and engineering, disc mastering, and film audio.

PIANO ACOUSTICS

The piano is an extremely complex radiator of sound. String vibration, elicited by a hammer blow, is transferred by the bridges to the soundboard, which vibrates perpendicularly to its surface not as a unit, but as a series of active zones which may vary in number and be out of phase with each other. In general, bass notes excite a few zones of large area, while higher notes excite greater and greater numbers of progressively smaller zones. To complicate matters further, it appears that the harmonics of a string may activate different areas of the soundboard than the fundamental. These multiple, frequency-dependent radiating zones and their phase characteristics complicate recording in the near field of a piano.

A listener or microphone array at a distance hears an integrated summation of these small-scale complexities. It is no wonder that close-miking of the piano has always been a difficult area in recording.

It should be kept in mind that tone does not come from the hammers, although some of the highest "airy" harmonics radiate directly from the treble strings. Microphones in the vicinity of the bridges are more likely to integrate a satisfactory average of nearby radiating zones on the soundboard, along with a percussive attack if that is desired. Less attack and more tone can sometimes be obtained by placing microphones so as to favor open areas of the soundboard. The particular scale of each make and size of piano has its own zonal radiating patterns, so experimentation will be necessary to find the best results.

John Eargle's article, "Studio Microphone Techniques" (**db**, December, 1980) addresses this problem, and demonstrates the large spectral variations from place to place in the near field of a grand piano. Close placement often emphasizes the instantaneous attack volume over the sustain, giving a "bangy" character. This factor is also susceptible to improvement in microphone placement and selection, and is a major element in a subjectively natural piano tone. ■

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JOHN BORWICK

Scene From Europe:
Tale of a Console for Broadcasters

Once upon a time...

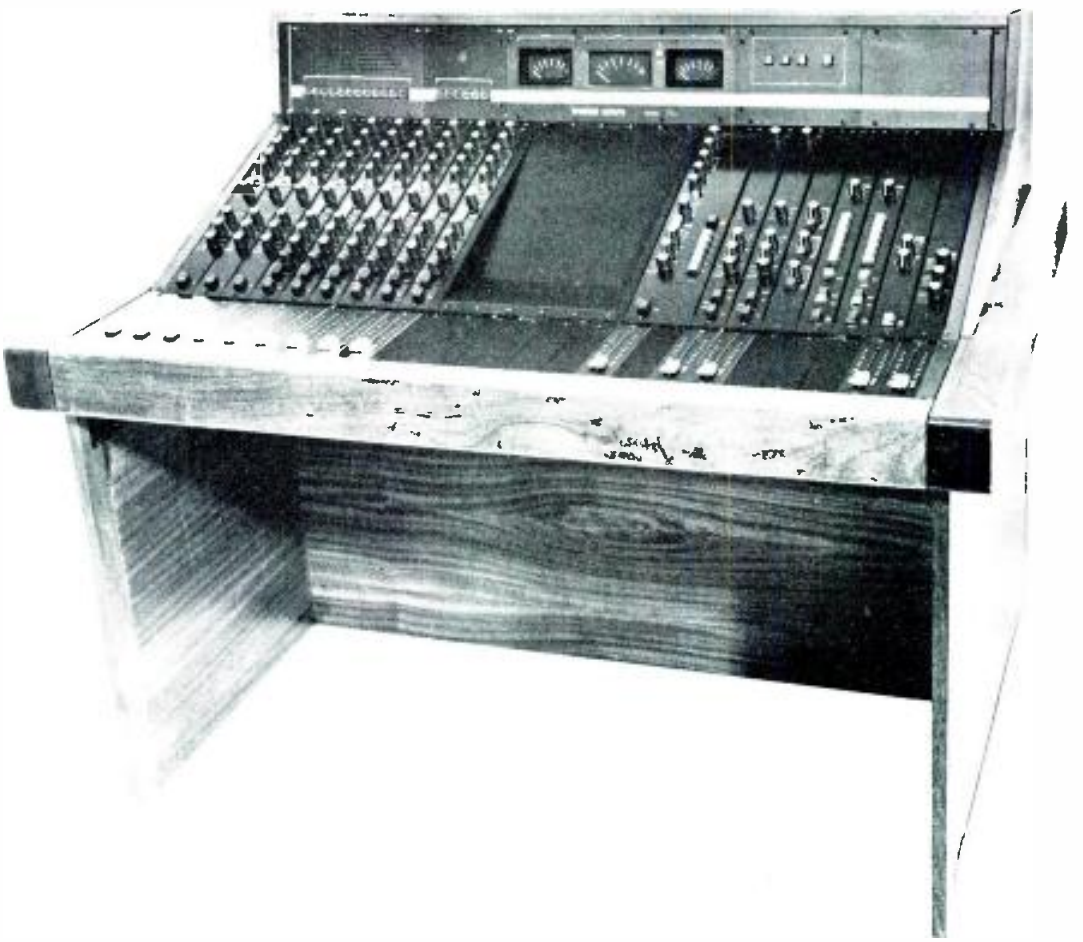
IN A DISTANT KINGDOM filled with mixing consoles, two young men were disappointed to find that none of the consoles had been designed specifically for broadcasting studios. The reason for this was not hard to discover. Ever since anyone could remember, radio broadcasting in that far-off land had been ruled by "The Beebe"; a big bad company, often called "Auntie" by the grateful citizens who lived in the shadow of its antenna. (Any similarity to the British Broadcasting Corporation is just one of life's little coincidences.) Now Auntie's radio was almost entirely a network operation, so it had but a very small number of studios. As a result, though the country had a large and thriving recording industry supported by an equally successful equipment industry, all the consoles and peripherals were built to suit the special needs of recording studios.

John Borwick is db's British correspondent.

In recent years, word reached this country that broadcasting was run on very different lines in other countries. In particular, it was rumoured that on the other side of the pond which bordered this country to the Westward, there was a large unification of states where not just hundreds but thousands of tiny radio stations broadcast daily to the local tribes. The idea seemed worth copying and soon both the Beebe and a new breed of "independent" broadcasters began to build local radio stations as fast as their government would let them.

The two young men, whom we might as well call Maldwyn Bowden and Michael Fabricant (for that is what their friends call them), set up a consultancy business to supply, install and commission broadcast studios—and also studios for production houses putting together packaged radio programs, commercials, jingles and the like. Finding no consoles exactly to their liking, for they both had a fair bit of previous broadcasting studio experience, they drew up a specification for a console that would do everything they wanted and went off in search of a suitable manufacturer to build the thing.

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The MBI series 24A Broadcast Mixer.

ENTER ALLEN & HEATH/BRENELL

After going up a number of paths which did not lead anywhere, their search eventually led them to the castle of Allen & Heath/Brenell, who were already expert at designing and manufacturing small and large recording consoles bearing such names as Modular III, Mini-mixer and Syncon Series A and B.

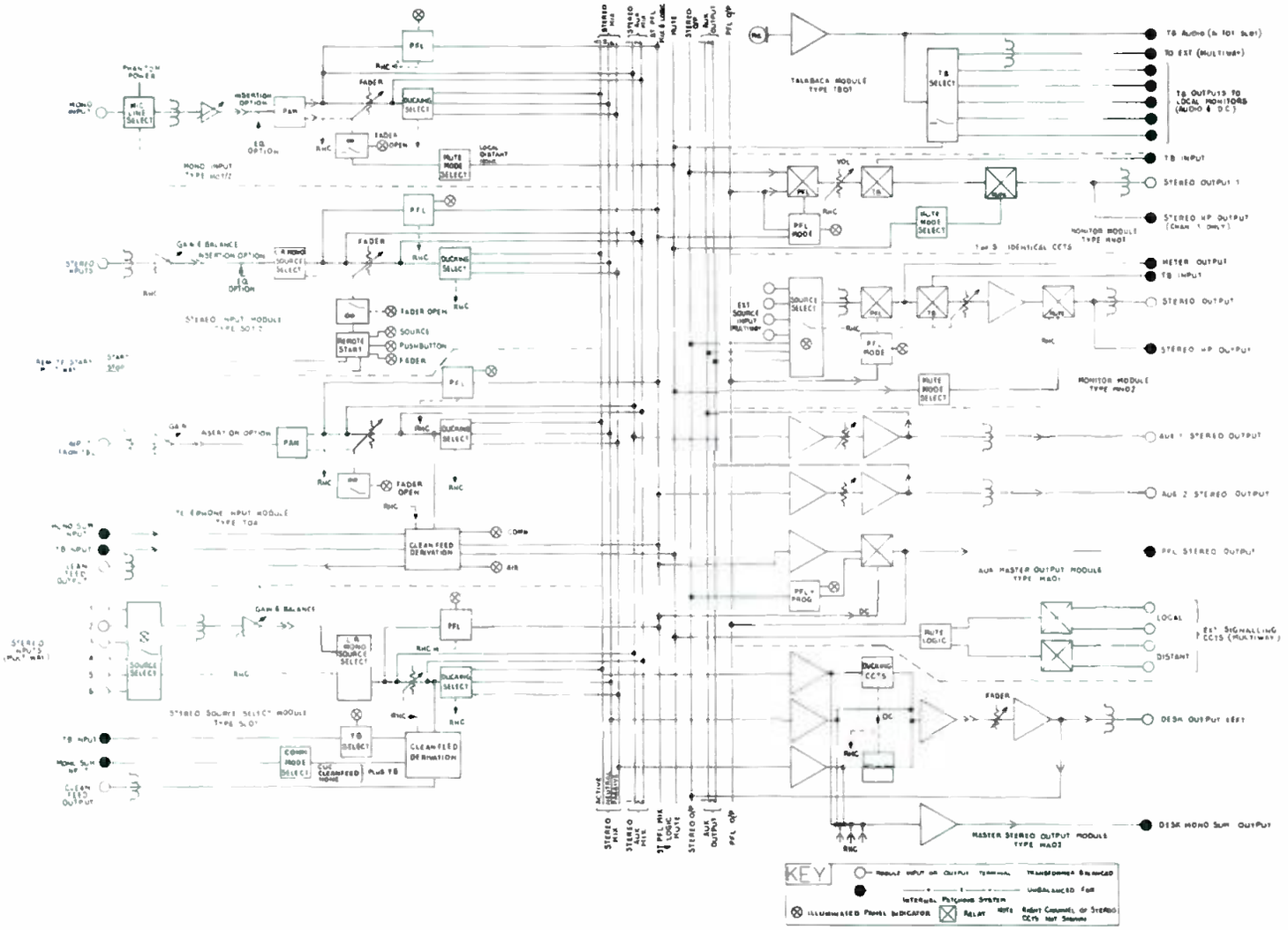
Fruitful discussions with AHB's electronics designer Ted Rook and production manager Carey Davies pointed the way to a merger of interests. A new company would be formed, with Allen & Heath/Brenell and the Maldwyn Bowden International Group owning equal shares. Mercifully the company name was abbreviated to MBI Broadcast Systems Limited.

About 18 months after our story began, the first prototype of the new Series 24A Broadcast Mixer were shown at professional exhibitions and created a great deal of interest. Even more important, they were submitted to tests by the Independent Broadcasting Authority (IBA) and were found to meet all the IBA Code of Practice specifications. As a piece of late news, I was told when I visited the MBI works that both prototype desks had just been sold—to the new IBA training school!

BASIC DETAILS

The console is certainly versatile. The approach has been totally modular, with the main frame carrying a sufficiently complex strip of multi-pin connectors over lots of bus-bars, to allow any module to be dropped in anywhere. The basic

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Systems diagram of the MBI Series 24A Broadcast Mixer.

chassis is pre-wired to accommodate up to 24 modules, though an extension offers a further 8-unit capacity. Nearest the operator is a flat horizontal area assigned to the fitting of 105mm-wide Penny and Giles stereo faders. These are plug-in units for easy replacement should the ingress of crumbs or spilt Coke be creating problems, and are wired to fade down towards the operator (except for the Beebe, who still likes to *up* towards the operator). Beyond the faders is an area sloping upwards at 20 degrees, where all module strips are housed. As the photograph shows, MBI also offer a script space panel. This is the width of six or ten modules and comes in two designs, one sloping and the other with a vertical back panel into which a clock or other production aids can be fitted. Above the sloping module area is a panel for meters, talkback units, etc. This is sloped just 10 degrees from the vertical to minimize unwanted reflections off the meter glass fronts.

The mixer may be free-standing or mounted into a wrap-round console incorporating disc or tape decks etc., which MBI can supply through their turnkey design and installation services. The layout is ergonomically suited to one-man operation, with all controls easily reached and all major functions illuminated.

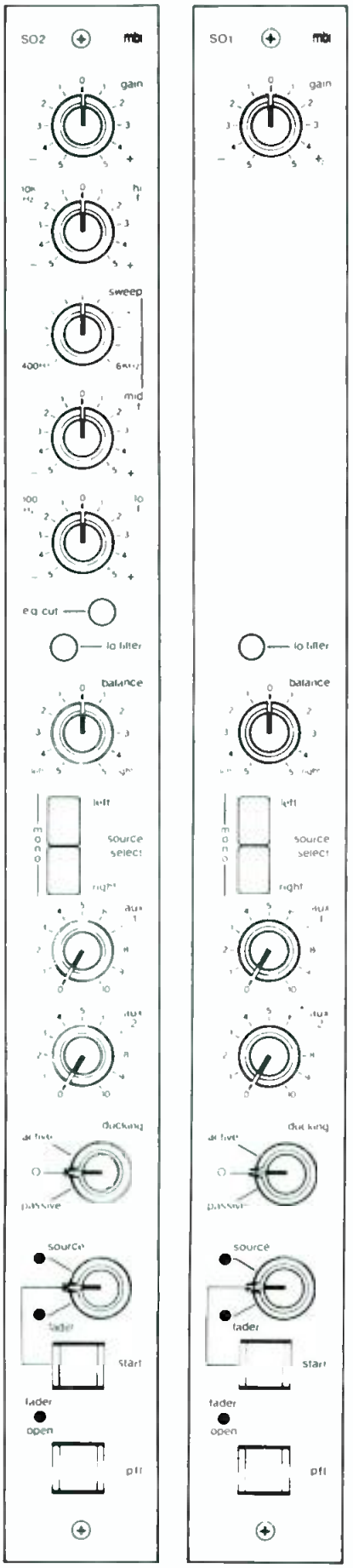
THE MODULES

On the input modules we can see features of special interest to broadcasters. Each has a ducking/routing switch, to allow any chosen source to be pushed down in volume whenever speech or music is present on any other designated source input. The switch has three positions: *active,* to make that source control the ducking; *passive,* to make that source do the ducking, and *neutral,* to do neither. The most obvious use of this facility is in a one-man operator/disc jockey studio to provide automatic voice-over, so that every time the presenter speaks over music, the music dips down in loudness. But there are other applications like giving priority to certain outside sources in a complex production, or speaking over audience or "atmosphere" microphones—or talking down a phone-in caller who is getting difficult or obscene. The depth of ducking (6 to 24 dB), attack time (1 ms to 0.5 s) and release time (0.1 to 2 s) can all be set on the master output module.

The latter allows selection of another handy broadcasting feature, "prefade-listen plus program." In the normal way, the PFL button on each input module will interrupt the program being monitored on previously designated monitor

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Front panel of the 24A.



speaker rings and meters and replace it with that input signal. (Incidentally, the PFL signal is derived after the panpot on mono input modules and the balance pot on stereo modules, to provide a "stereo in place" positional check on the prefaded source as well as confirmation of its sound quality, equalization etc!) In the "PFL + prog" mode, however, the monitored program continues at a reduced level (–20 dB). This could be useful in a live show where the presenter has a disc "on-air" and wants to set up another disc or tape, or brief a contributor in another location, without missing his cue at the end of the music.

"Clean feed" is another facility demanded by broadcasters and means that the monitor feed or "foldback" sent to each contributor contains everything in the program *except* his own voice. This is often needed to avoid howlround with loudspeaker monitoring, and confusing a contributor listening on headphones if, for example, there is some time delay via tape or satellite. Clean feed is available to each outside source and the loudspeaker monitoring rings can similarly be designated local or distant. The microphone channels can be switched to correspond, so that only those speakers liable to cause howlround are muted when any given microphone is brought in.

In other ways the microphone and line input modules look pretty much like recording console strips, with input gain control at the top, optional three-band equalization, switchable high-pass filter (12 dB/octave below 100 Hz), pan control on the mono modules and 12 dB balance control on the stereo modules, and two auxiliary send potentiometers which can be either pre- or post-fader. Both auxiliaries send a stereo signal which can be monitored and routed through master auxiliary gain controls on the output modules. Insertion points are available as an option on all input modules, and 48-volt phantom power for microphones is switchable on all mono modules. Inputs are transformer balanced, and floating via female XLR-type connectors. Stereo line input modules offer flexible remote control facilities. A three-position switch assigns remote tape (or other machine) start-and-stop to an adjacent push-button, or to when the fader is opened, or to the source itself, i.e. non-remote. This again gives the one-man studio a useful measure of flexibility.

Two other types of input module suit different radio stations. The first is a six-source line select module giving push-button selection of stereo sources together with independent clean feeds, talkback and cue program. The other is a telephone line input having alternative on-air or communication modes so that a number of phone-in callers can be briefed or interlinked for conference discussions. Individual callers may be prompted by the mixer operator without going on-air or distracting other callers.

Monitoring via headphone and loudspeaker rings can be as versatile as desired. Three-way and multisource (seven-way) monitor modules are available allowing each stereo ring to receive the console main output, auxiliary outputs, various external sources and/or dedicated talkback and prefade listen signals. The monitor signal may be muted, dimmed or converted to mono to check mono compatibility by means of separate push-buttons. Meter modules can be PPM or VU, with three meters being built-in to monitor stereo main output, mono sum, PFL, auxiliary sends and stereo external sources as required. There is also a peak level warning lamp which lights if the left, right or summed mono signals exceed a preset value (usually +8 dBu), and a stereo headphone amplifier delivering up to 10 watts per channel into 8 ohms. A choice of talkback, intercom and transmitter interface modules complete the MBI Series 24A stereo mixing console. The conception adds up to an unusually flexible, modular scheme and the benefits of having experienced broadcasters in at the beginning of the design planning are clear enough. Potential customers for such a mixer now exist worldwide; not just in countries already enjoying widespread local radio but the many countries only now feeling their way towards "your friendly local community radio station"—without which none of us could surely live happily ever after. ■

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db People/Places/Happenings

• As a result of the success of "**Mark Levinson Presents**," the first album in the **dbx** Recording Technology Showcase Series, dbx is releasing the second volume in the Series, entitled, "**Beyond The Sound Barrier**," according to announcement by **Jerome E. Ruzicka**, dbx vice president and director of the dbx Encoded Disc Program.

The series, introduced when the dbx Encoded Disc Program was launched a year and a half ago, was created to produce recordings made by technical and/or musical specialists whose efforts have resulted in an improvement in the quality of recorded music. "Beyond The Sound Barrier" was produced from original digital recordings employing the **Soundstream** system and features concerts with **Morton Gould** and **Lee Holdridge** conducting the **London Symphony Orchestra.**

• New York's first fully-equipped video and hi-fi recording studios have been opened to help meet the new demand for program material for video disc and cassette software, cable TV production and commercial TV spots. **The Hi-Five** studios (at 237 West 54th St.) are equipped with 16-track and 8-track recording studios together with four camera TV-recording capability. A spacious 18 ft. high studio has a movable video isolation booth and a lighting grid with 12,000 watts of floods and spotlights as well as special effects generators. A smaller studio, with 8-track audio recording equipment, is set up for lighting and video-taping less mobile subjects, such as talk shows. Separate audio and video-editing and tape copy rooms are also housed in the fifth floor complex. The large soundstage also features an 18 foot shooting balcony. The facilities have already been used by such stars as **Mickey Rooney**, the **Sugarhill Gang**, and a number of advertising agencies for a production of commercials.

• **Peter B. Scharff**, president of **Scharff Communications, Inc.** (SCI), announced that his firm has added 3M 32 track and 4 track digital recorders to its rental inventory. In a joint venture with **Audio Video Rents** of San Francisco and **Record Plant West** in Los Angeles, Scharff Communications will rent the 3M system throughout the United States and Canada, with exclusive rental rights in the Eastern time zone. The recorder is housed in a special showroom at SCI's Manhattan headquarters. 3M 32 track mastering equipment has been used to record platinum albums by **Herb Alpert** and **Christopher Cross**, and has also been used by the **New York Philharmonic Orchestra**, the **Chicago Symphony Orchestra, Linda Ronstadt, Ry Cooder, Bonnie Pointer**, the **Boston Symphony Orchestra**, the **Berlin Philharmonic, Devadip Carlos Santana, Herbie Hancock** and the **St. Paul Chamber Orchestra.**

• **Rupert Neve Incorporated** of Bethel, Connecticut, the world's largest specialist in the design and manufacture of professional audio mixing consoles for the broadcasting, music and film industries, is proud to announce that the first NECAM II in North America has just been installed and is now operational at **Motown Recording Studios** in Hollywood. NECAM II is a further development of the Neve NECAM I system originally designed as a computer assisted sound recording mixdown system. The NECAM II is expanded by the addition of numerous facilities particularly suited for TV sound post production. Motown Recording Studios originally started in Detroit under the name of Motown Hitsville USA and after great success during the 1960's the operation was moved to Hollywood where they operate a number of newly redesigned and re-equipped recording studios. Motown took delivery of their first Neve console in 1978.

• **Bob Todrank**, executive vice president and marketing director of **Valley People, Inc.**, announced the death of the original **Allison Research** Kepex and Gain Brain Signal Processing equipment. After almost 12 years in production, Valley People is discontinuing the Kepex, Gain Brain and CM-001 console mount as of June 1, 1981. Customers will be able to purchase these units until that date. The RM-160 and LX-100 Power Supply units will be discontinued as of March 15, 1981. They will be replaced by the new Valley People Kepex II and Gain Brain II.

• **Arthur H. Hausman**, a director, president and chief executive officer of **Ampex Corp.**, was recently elected to the additional post of chairman of the board of directors. He succeeds **Richard J. Elkus**, who retired January 31 as a director and chairman of the board. The board of directors also amended the company's by-laws to increase the board's size from 10 to 14 members, and elected five new members. They are: **Forrest N. Shumway**, chairman of the board and chief executive officer of **The Signal Companies, Inc.**; **Daniel W. Derbes**, president of Signal; **Charles S. Arledge**, group vice president of Signal; **John A. Teske**, president and chief operating officer of **The Garrett Corporation**, a Signal subsidiary; **Charles A. Steinberg**, executive vice president of Ampex.

• **Los Angeles Broadcasters, Inc.** reports that its new media center, the **LAB**, which will train people for careers in broadcasting, has purchased $95,840 worth of audio production console packages, including turntables and cabinetry, plus main studio production equipment, from the **Cetec Broadcast Group**, Carpinteria, California. The LAB has also acquired $53,000 worth of reel-to-reel tape equipment through **Audio Systems West**, Santa Barbara. The tape machines were supplied by the **Boynton Studio, Inc.**, Morris, N.Y., according to **Jerry Clements**, owner of Audio Systems West and western sales manager for Cetec.

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When he was 16, Humberto moved to the U.S. from Chile, where several of his relatives were successful singers. He worked on an assembly line for a while, before wandering into MGM Studios. A year later, when an engineer got sick before a major session, Humberto was the only one around who could get the job done. He's been getting the job done ever since for an incredible variety of people, from Debbie Boone to Alice Cooper, as well as Frank Sinatra, Sammy Davis Jr., Steve Lawrence, Tony Bennett, Shaun Cassidy, The Osmonds, David Bowie, Denise Williams, Gladys Knight, Bill Champlin, Lee Ritenour, Hall and Oates, Leo Sayer, The Average White Band and Bernie Taupin, whose album he produced.

ON RECORD BUYERS

"When you make hits, you have to think hits—14, 18, young. The people have to be realistic. How many albums is a 27-year-old guy going to buy, as opposed to a 15-year-old? I mean, you go to a record store. Maybe a 16-year-old is going to buy four albums. A 23-year-old is going to buy one or two—he's very picky. He might buy very specific groups that he likes. He might follow critics. When you make records, you have to think kids. Those are the guys who buy the records."

ON RETAKES

"I hate perfect records. You cut the basic track, the vocals, and then the producer goes all the way back again. He starts replacing the drums. And then he replaces the bass, because the bass doesn't feel quite right. And then he starts doing the keyboards again. So that by the time he's finished, he's done it all over again. If it's not right, I understand. Let's do it all over again. But when you start patching things that already have the specific feel in there—that 'something' that has already been printed—you can hear all the human things that are all there for the first time—I don't want to be a part of that. I have been part of one of those and it just drove me crazy."

ON NOISE REDUCTION

"I don't use any noise reduction. I never use it, either when I'm doing tracks or when I'm doing final mixes. They really affect the music. They affect sound in general. To me, the punch is all gone. The drums sound different. The vocals sound different. The keyboards sound different. I can hear those things and it really bothers me, so I don't want to be a part of it."

ON TAPE

"Since I started with MGM, we always used Scotch. Only once, I've experienced a different brand of tape. And I was very disappointed. And I had a serious problem. It got so bad, like in the middle of the mixes, the tape started giving up—heavy drop-out in places. And then the tape started peeling. Not on the outside. It was giving up on the inside. I mean, I was doing a mix, and halfway through the song, the whole top end disappeared, like someone threw a blanket on top of the speaker. So we mixed about halfway through the album. We mixed in sections. We cleaned the heads all over the place. We did the introduction. Clean the heads again. We don't want to take chances. I wouldn't do a project with any other tape besides the 250. I have done the past 20 albums, the past 30 albums all on Scotch. It gives me what I want, and what I want is a real clean taping, punchy bottom end, very little hiss, almost none. You have to try things in order to know if you're doing the right thing. If you don't try, you'll never know. And I have tried, and the results have been different."

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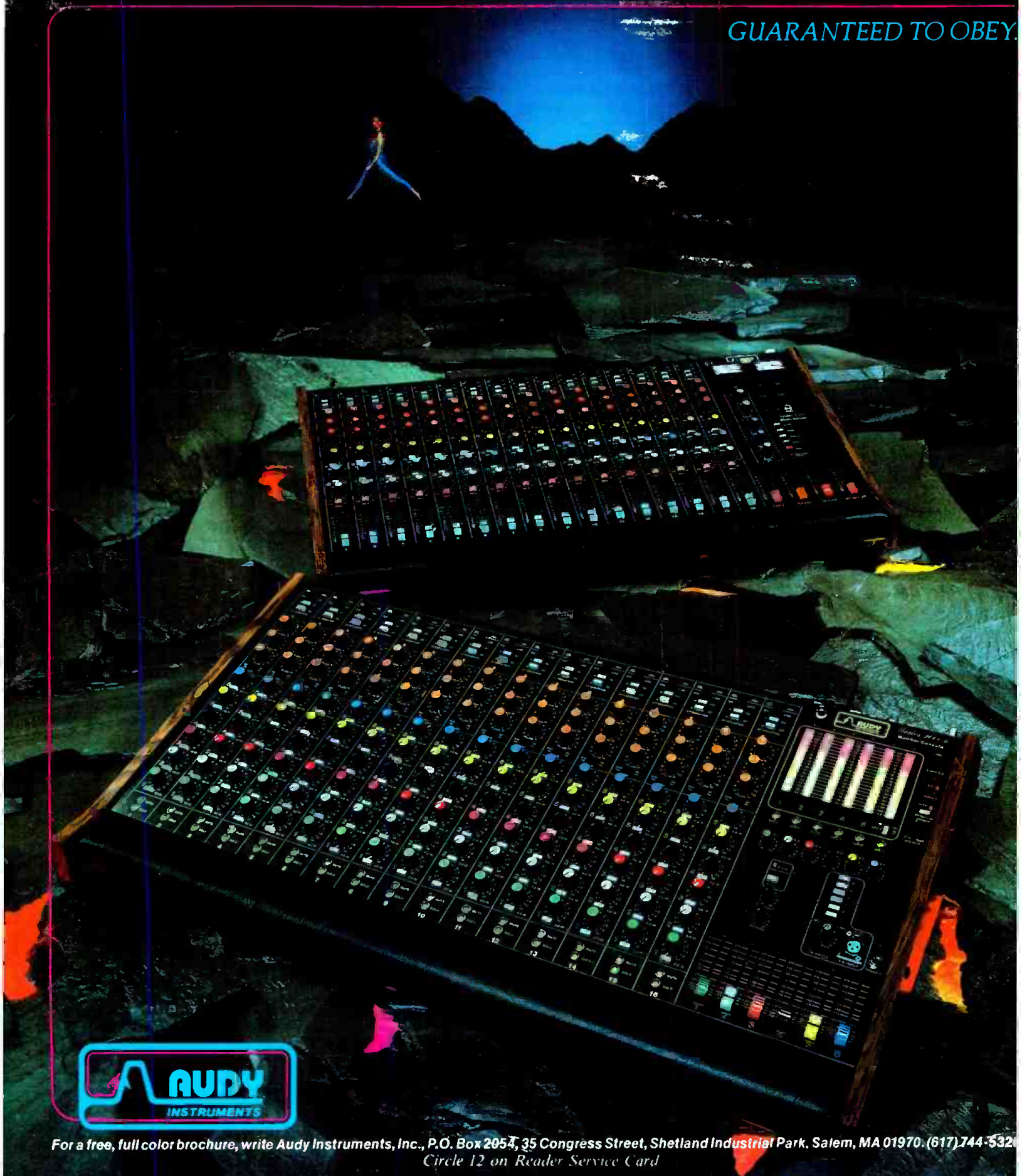
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